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FOG SIGNALS AT THE CENTENNIAL.

MESSRS. A. & F. BROWN, of New York City, exhibit their fog signal for coast service. The peculiar form of signal invented by this firm is termed the "Siren," and consists of two disks of composition brass of the mixture known as "steam metal." The disks are about twelve inches in diameter, and are provided with openings passing entirely through them, the sound being produced by revolving the disks in opposite directions, their faces being in contact while air or steam under pressure finds egress through them, and thence passes to a mouth-piece two inches in diameter. The exhibit at the Centennial shows the Siren in operation by compressed air and by steam.

The hot-air engine for supplying the compressed air, shown in our engraving at Fig. 1, is of the following construction: The furnace is cylindrical in form, and its internal dimensions are two feet diameter and two feet high. The air required for the combustion of the coal is supplied to the furnace under a pressure of from 15 to 25 lbs. per square inch. The fuel is fed to the furnace in the following manner: Upon the top of the furnace is a hollow casting containing a valve which is kept closed, except during the operation of feeding. Above this, and in the same casting, is another valve, which is usually kept open save during the operation of feeding. The coal is placed in the casting between the two valves; the top one is then securely closed, and then the bottom one is opened, and the coal falls into the furnace. The lower valve is then closed and fastened, and the top one is opened, ready to receive the next charge. To facilitate the lighting of the fire the furnace is provided at the front with two man-holes, which are afterwards sealed with caps having a ground joint, and when the engine is in operation the air is fed to the furnace in such a way as to strike these man-holes or hand-holes, as they may more correctly be termed; first, the object being to keep them as cool as possible. The caps are provided with square projecting ends, which are for the purpose of facilitating the grinding, in case of leakage, without taking them entirely apart.

The bore of the main cylinder is 32 inches in diameter, the stroke of the piston being 20 inches. This cylinder is composed of an upper and a lower section, the piston fitting into the upper one, and having about a half inch clearance in the lower one, which is also cast somewhat thinner than the upper, so as to facilitate keeping it cool. The piston is of the plunger type, and is solid, after the manner of a trunk piston. The packing is effected by leather placed at the top of the cylinder, and thus as far out of the way of the heat as possible. This is done to preserve the leather. Lubrication with oil is easily effected by oiling the plunger from the outside of the cylinder. The connection between the main cylinder and the air pump is effected by means of a reciprocating beam and connecting rods, as shown in our engraving. In addition to the latter, there is, however, a connecting rod communicating motion from that end of the beam to the crank shaft and fly-wheel The crank is of steel, and is about 4½ inches in diameter and 6 feet long. The fly-wheel is 8 feet in diameter, and weighs about 2400 lbs. The air pump is 22 inches in diameter and has a 22-inch stroke. The piston is packed with leather packing, the cylinder being bored throughout, whereas the main or working cylinder is bored for a distance of 15 inches, from its top only. The air pump is also single-acting, and is lubricated with oil. The valves, both suction and delivery, are of the poppet order, which are adopted to avoid the noise due griddle or lappet valves.

The piston rod, or rather guide rod, for the main piston is about 3 inches in diameter, the guide being bolted to two uprights, which are in turn bolted to the top of the cylinder.

The products of combustion leave the furnace through the pipe shown in our engraving, which pipe is of cast steel and has a bore of 6 inches. The induction is regulated as follows: The steel pipe above referred to is bolted to the valve, the casing of which appears in our illustration, and to which is bolted the bracket guiding the valve spindle. To the top of the valve stem is attached an eye, and to the top of the bracket, which acts as a guide to the valve stem, is secured an arm. Into an eye in the latter is pivoted a lever which passes through the eye on top of the valve spindle, and extends over a wiper or toe which is operated by an eccentric attached to the outer end of the crank shaft. A late improvement consists in an adjustable cut-off. Above the lever shown in our illustration as operating the induction valve, is placed yet another lever pivoted to the top of the eye carried on top of the valve spindle, the distance between the two levers being about an inch at the centre of the top lever. Upon the top lever, near its pivoted centre, is a cam projection, and since the lower lever is free to operate between the jaws of the eye, it follows that, though the lower lever be raised, it will not lift the valve until such time as it comes into contact with the cam projection. To adjust the distance between the lower lever and the cam projection upon the upper one, the pivot of the end of the lever shown is bored to form a journal bearing for a screw operated by a crank handle. This screw enters a pivoted nut in the top lever, so that the distance between the levers, and hence the point of cut-off, is easily regulated by the crank handle. To increase the range of the device, however, the top lever has a hooked projection extending over the lower lever and the wiper, so that when the cam projection becomes from its position inoperative, the hooked end will act instead. The fall of the induction valve is effected by means of the spiral spring shown upon the valve spindle. The exhaust valve is operated by an eccentric, also upon the main shaft, through the medium of a wiper. The engine is governed by an ordinary fly-ball governor attached to the induction valve. The total weight of the engine is about six tons, and the floor space occupied is about 11x6 feet. The brasses on all the rods come to a butt joint, and the whole of the workmanship is substantial, without any attempt at elaboration. The action of the siren is in connection with the steam siren shown in Fig. 2, thus described by the inventors: "It is generally well known that to produce sounds the air must be thrown into a succession of waves, which, in their vibration upon the ear, give a sensation called sound, and that the kind of sound, as shrill or grave, varies with the velocity of said waves. For such a purpose, an elastic force such as steam or air may be generated or held in

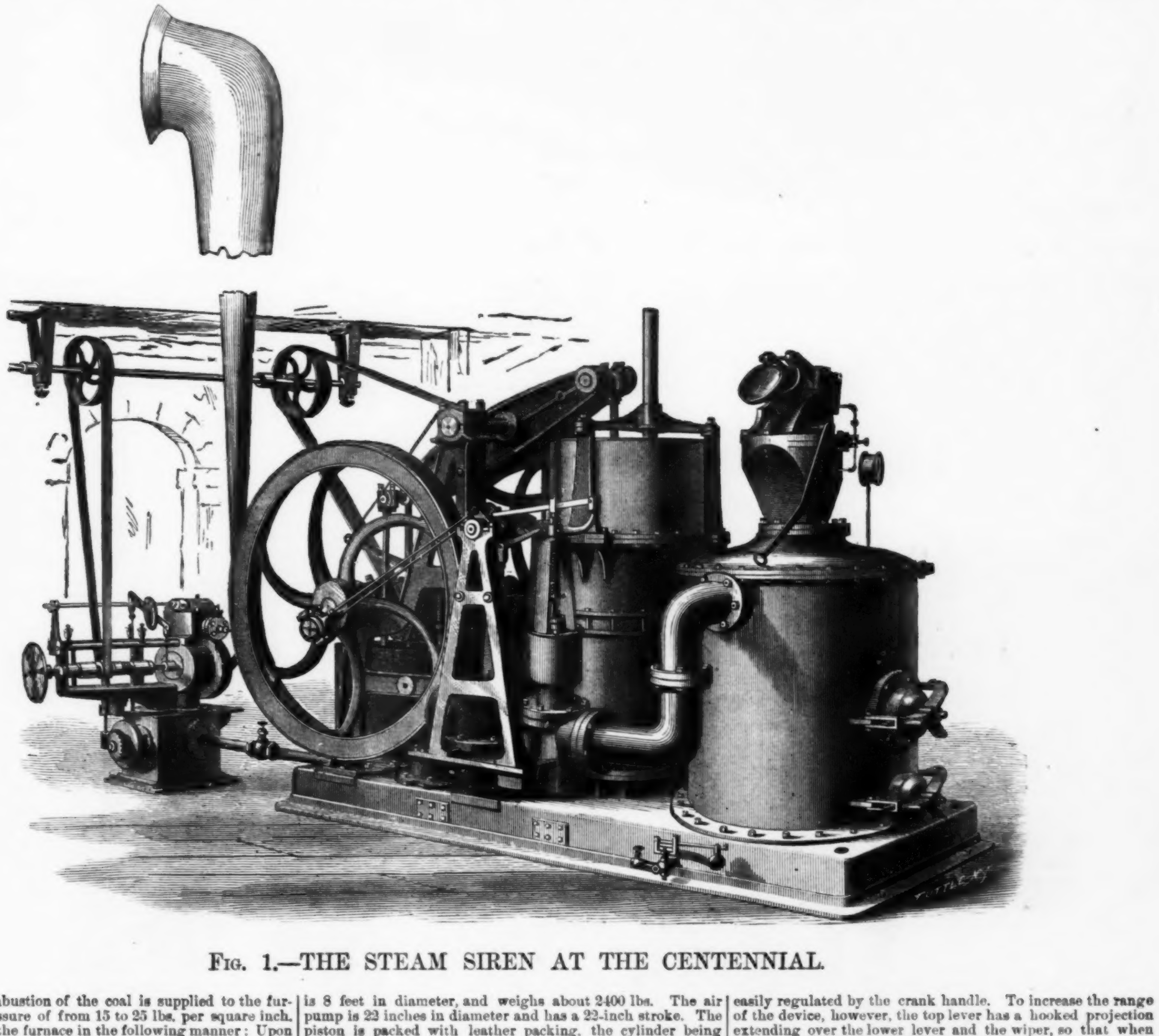


FIG. 1.—THE STEAM SIREN AT THE CENTENNIAL.

a boiler or receiver, as at A, Fig. 2, upon the dome of which is mounted a valve as at B, and to one side of said valve is attached a trumpet or director and resonantor of the sound waves as at C. The valve is combined with suitable rotating mechanism as at D, which may also act to supply the boiler with water. The valve D is a disk made with a number of openings corresponding to the mouth-piece of the trumpet, and so

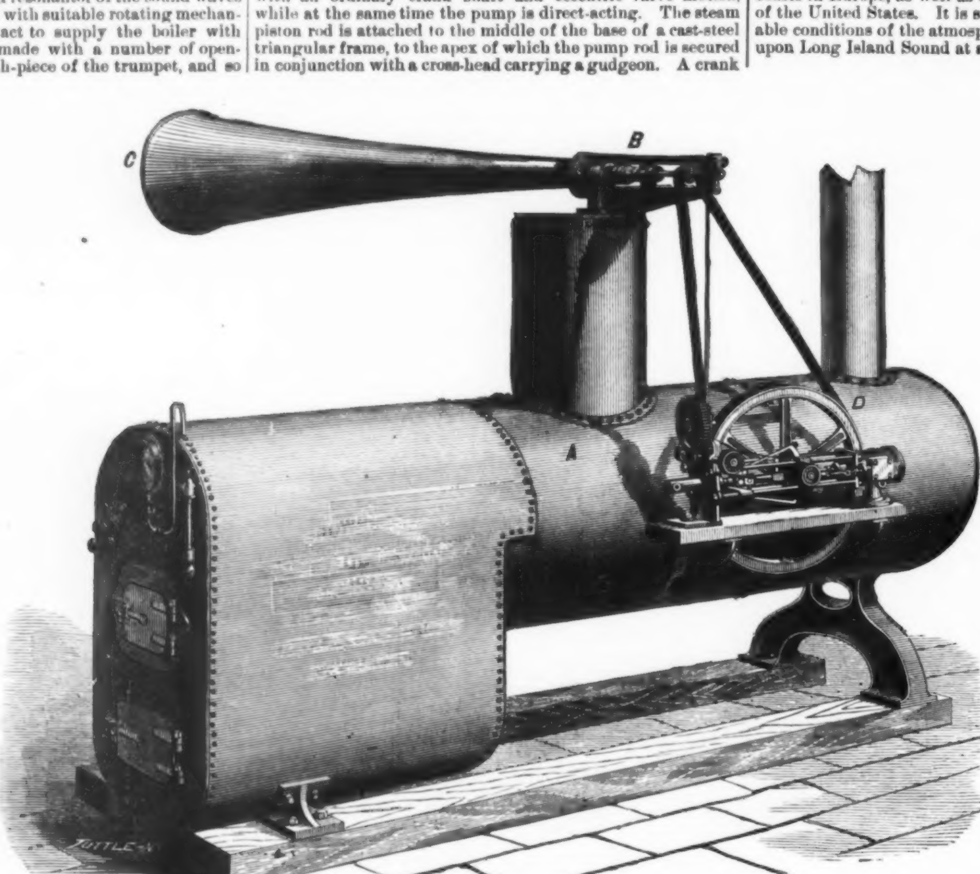


FIG. 2.—THE STEAM SIREN AT THE CENTENNIAL.

arranged that as the valve rotates, which it does at a speed of from 2000 to 2800 revolutions per minute, a free opening from the valve chamber to the trumpet will be made as each hole in the valve passes the mouth-piece of the trumpet. Hence if steam or air under pressure be admitted from the boiler to the valve chamber, and the valve be made to rapidly rotate, a series of vibrations will be produced in the trumpet which will impart to the air waves creating a sound in amount varying according to the pressure of the steam or air, and in tone varying according to the rapidity of the rotating valve. To make the action of the siren intermittent, a simple cam movement to turn the steam on and off is all that is necessary, and the movement is arranged so that each blast shall last as long as is considered desirable. The motive power in the case of the steam siren is supplied by a steam engine and pump combined, the device being shown in our engraving attached to the side of the boiler. The engine is furnished with an ordinary crank shaft and eccentric valve motion, while at the same time the pump is direct-acting. The steam piston rod is attached to the middle of the base of a cast-steel triangular frame, to the apex of which the pump rod is secured in conjunction with a cross-head carrying a gudgeon. A crank carrying a fly-wheel and the eccentric for the engine slide-valve operates inside the triangular frame. The connecting rod is attached to the crank at one end, and is forked at the other to connect with the bearings on the gudgeon above mentioned. The guiding of the pump rod, which becomes necessary because of the angularity of the connecting rod, is accomplished by bolting to the bottom of the triangle, close to the apex, a guide sliding upon the two lower stay bolts, or rather rods, referred to as connecting the two cylinders together.

The pump is a single-acting plunger-pump, having a 2-inch bore and a 5-inch stroke, the steam cylinder being 5 inches bore by 5 inches stroke, and the crank makes about 150 revolutions per minute. The whole device is compact and simple, while all the parts are under the operator's eye, and easily to be got at in case of necessity. Fog horns of this description are now placed upon the English, Scotch, and German coasts in Europe, as well as on the Atlantic and Pacific coasts of the United States. It is said that under peculiarly favorable conditions of the atmosphere, one of them has been heard upon Long Island Sound at a distance of thirty-six miles.

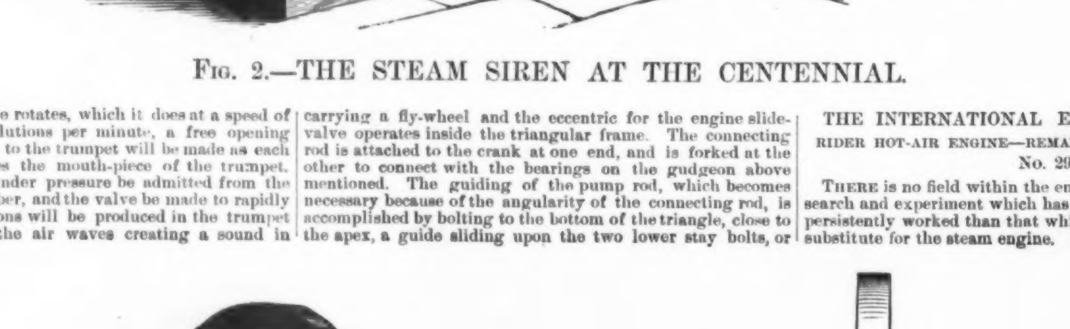
J. R.

THE INTERNATIONAL EXHIBITION OF 1876.

RIDER HOT-AIR ENGINE—REMARKABLE STEEL SHAVINGS.

No. 29.

THERE is no field within the entire range of mechanical research and experiment which has been more thoroughly and persistently worked than that which looks for some available substitute for the steam engine. The inherent defects of this machine—man's most productive and powerful servant—are so great, that it has appeared to inventors, men of science, and investigators of Nature's laws generally—while it has proved the most difficult—the most promising path to the opening up of large results.



HOT-AIR ENGINES AT THE CENTENNIAL.

Thermo-dynamically considered, the steam engine appears as a voracious monster, consuming the coal deposits of the

world with advancing rapidity, only to waste about nine tenths of what it consumes. At best it returns to us in the shape of work or actual energy but about ten to fifteen per cent of that resident in the fuel burned in the furnace, while in many forms of the smaller machines the loss of energy amounts to fully ninety-five per cent.

The danger attending the use of steam boilers, too, has formed a principal incentive to supplant them by something of a safer nature; and these, with considerations as to cost of machinery, expense of running and maintaining, and others of less moment, have made this a favorite though discouragingly unsuccessful field for experiment and study on the part of inventors and scientific men.

These attempts have taken many directions, and notable among them are the various gas engines, electro-magnetic, petroleum, and hot-air engines. With the single exception of the petroleum machine, which as yet is in its infancy, and to some extent problematical, the hot-air engine is the only one that has approached the steam engine in point of efficiency and economy; while the mechanical difficulties attending the production of power on a considerably large scale in this way have been found to be so great, that only for quite small motors has even the hot-air machine met with success as a substitute for it.

The gas engine, as we find it best represented to-day in the machine of the Messrs. Otto & Langen, illustrated some time since in this journal, is confined to very moderate dimensions, from the same mechanical considerations as with the hot-air machine, while at best its efficiency is far below that of the steam engine itself.

The hot-air engine for small powers has during the past twenty years made a steady advance, as its defects, with reference particularly to its endurance and wear, have been overcome, until now there are several forms of it in use, which are doing good service, costing but a nominal sum for repairs and maintenance, and economical beyond any other known motor.

In the machine herewith illustrated, the elements of safety, durability, simplicity, and economy are embodied most completely, and as applied to the elevation of water it is a most felicitous contrivance.

Fig. 1 gives an exterior view, showing the pump attached to the side of the cooler and driven directly from the compression piston. This pump has Mr. Rider's patent rolling valves. Fig. 2 shows a vertical section through both cylinders. In this figure, A is the compression and B the working cylinder; the pistons in each are respectively C and D. H is the regenerator; E, the cooler; and I I, the cranks connected to the shaft at an angle of about 95°. L is a small check valve for the purpose of admitting air to replace any leakage which may occur.

The compression piston extends to within a very small distance of the bottom of the cylinder, when its crank is on the lower centre, and is a little less in diameter than the cylinder, thus leaving but a thin film of air to be cooled when in this position. The piston D similarly reaches the bottom of the working cylinder, and conforms to its shape so as to leave the air to be heated in a similar thin film. The bottom of the working cylinder returns within itself, like the bottom of an ordinary bottle, as seen at F; and from a point level with the top of the passage to the regenerator a thin auxiliary cylinder, G, passes down inside B to near the bottom, leaving an annular space between them, and causing the entering air to take such a circuitous course as to insure its rapid heating by the fire below and the gases surrounding the lower end of the working cylinder.

Revolutions per minute	130
Increase in volume of air	1.07
Foot pounds per revolution	218.6
" " " minute (130 revs.)	28,428
Mean unbal. pressure, cold cylinder	7.4 lbs.
" " " hot "	15.35 "

Developing the power shown by this diagram (about $\frac{87}{100}$ I.H.P.) continuously for 10 hours, the consumption is about 30 lbs. of coal; equal to nearly 3.5 lbs. of coal per I.H.P. per hour, which is decidedly more economical than the performance of the best steam engines of this small power. The very best steam motors that can be obtained to-day, developing about one I.H.P., will require from 50 to 75 lbs. of steam per I.H.P. per hour, which, with a fair boiler, corresponds to the consumption of 7 to 10 lbs. of coal. So far as economy is concerned, therefore, these machines are far ahead of the steam engine, for the kind of work for which they are designed.

If we add to this consideration the facts that it is perfectly safe under all circumstances, that it is extremely simple, practically noiseless, costs little for attendance, and occupies but little space, it is, for ordinary purposes of power, a most desirable machine; but for pumping purposes it has still greater advantages, and aside from the moving or raising of water in large quantities, it is certainly one of the most economical, simple, and effective devices.

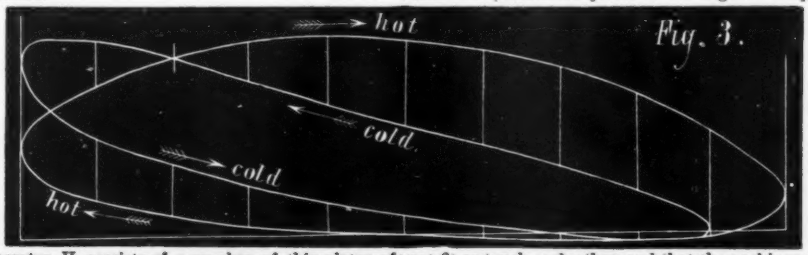
In the various forms of gas and petroleum engines, as with any piston motor working with high temperatures, the only means by which the interior of the cylinder, the piston, rods, etc., can be preserved in a working condition for any considerable time, is that of the circulation of considerable quantities of cold water about the exterior of the cylinder and the interior of a hollow piston; and in this way very large quantities of heat are carried off. So great is the amount of heat disposed of in this way, that experiments on some forms of gas engines have shown that with a range of temperatures within the cylinder, from an initial one of 1500° to 600° for the exhaust, more heat units were carried away in the circulating water than in the exhaust and all other channels combined. This does not hold so true of the Otto & Langen engine as of all the other gas motors, as a part of the heat in their case is carried away by the atmosphere coming in contact with the interior of the single-acting cylinder.

This would hold good against the hot-air engine of Mr. Rider, proportionately to the range of temperatures at least, if it were not for the regenerator, and would reduce the efficiency of the machine accordingly; and the small part of the heat which escapes past the regenerator, as well as that which is retransmuted from the neck of the working piston in compressing the air in the compression cylinder, is carried off in a similar manner, by a circulation of cold water in a jacket, E, surrounding the compression cylinder.

For the purposes of ordinary power, the quantity of water required is very small in proportion to the power of the machine, and in a large majority of situations will add little or nothing to the expense of running it, and where used for elevating water the entire water discharged by the pump is made to pass and circulate through the jacket E on its way to the reservoir or point of discharge.

It can hardly ever be the case that the small amount of heat imparted in this way to the water lifted can be an objection, while in winter it may subserve a good purpose by preventing freezing, and in many situations be useful.

It will be seen that, in this machine, those parts of the pistons and cylinders subjected to the highest temperatures do not fit or touch each other, and that the packings are well removed from the influence of the heat, so that it may perform under much higher temperatures in the working cylinder than would be possible with a tightly fitting piston, such as is used in the gas and petroleum engines; and that, therefore, it has the advantage of the economy resulting from a large range of temperature in the cylinder, without the destructive action of highly heated metals, when working one upon another; and as hitherto this has been found to be one of the principal obstacles to the successful use of hot-air engines, this machine will doubtless mark a decided advance in small motors, and particularly for lifting water. It is provided with a governor, which regulates the speed by controlling the escape of small quantities of the compressed air from the bottom of the cold cylinder.



The regenerator, H, consists of a number of thin plates of metal slightly thickened at their edges where they come together, which has been found to be a better form for this important part of the machine than the customary wire gauze; for while it offers in comparison with the latter little resistance to the passage of air through it, it effects a more rapid interchange of heat, whether abstracting it from or imparting it to the passing air. In fact, experiments made by Mr. Rider show that an interchange of heat between metallic surfaces and air in contact therewith can best be done by having the first in a comparatively continuous surface, and the latter in a thin film upon it; and he has carried this principle into all parts of the machine which subserve this purpose.

The office of the regenerator is to economize heat, taking it from the air on its passage from the working to the compression cylinder, and *vice versa*.

The two pistons are packed, each by two rings of leather, having their inner diameters something less than that of the piston, and between them a metal ring, not quite fitting the piston, thickest at its inner diameter, such that it turns the inner edges of the leather rings, the upper upward, and the lower downward, thus relieving the piston almost entirely of friction from them. Those surrounding the working piston are kept from being overheated by the circulation of a small stream of water in a depression on the upper side of the cylinder head. In this engine the same air is used continuously, and there are no valves or similar mechanism to get out of order.

In the operation we may suppose the compression piston first to compress the air in its downward movement, as it will do, from the fact that the two pistons are so connected that the volume contained in both cylinders and intervening passages is not materially increased until the compression piston begins to rise; when the compression piston begins again to rise the increase of volume is supplied by the heating of the air in the working cylinder, the maximum pressure being reached in the latter at about the middle of its upper stroke, and in the compression cylinder at or near the end of its lower stroke. Fig. 3 shows an indicator diagram from each of the cylinders, the compression superimposed upon the working card, and their lengths being proportional to the strokes of the two pistons.

The following are the data from these cards:

Indicator scale	16 lbs. = 1 inch.
Diameter of hot cylinder	6.75 "
" " cold "	6.75 "
Stroke of hot "	9.50 "
" " cold "	8.60 "

In addition to two sizes of pumping engines, and two for power purposes, ranging from one to three H.P., they exhibit a smaller and special machine, termed the "Minimotor," which is intended for such light work as the driving of sewing-machines, dental engines, knitting-machines, drug mills, jewellers' and other small lathes and machines, for which purposes a safe, simple, and economical motor is a great desideratum. It is made to be run by means of a gas-burner, and is so light, handy, and easily placed, that—although necessarily not so economical as in the form with which coal is used—it seems to be one of the best and cheapest means of obtaining very small powers yet produced.

Mr. Rider's long and persevering labors in this direction have culminated in a series of machines which will be found of great value to the community.

Among the many curiosities in the way of steel cuttings or shavings which were shown in the different iron and steel exhibits at the Exhibition, are two exhibited by Mr. Fried. Krupp in connection with his extensive exhibit in Machinery Hall. Some of these shown in the Swedish department in the Main Building were most notable as being the longest continuous steel shavings in the world, and were placed in illustration of the great toughness of some of their products; but this, together with the very nice manipulation required for their successful production and preservation, is all that was shown by the form of chip or shaving there exhibited; no particular merit attaching to the machines producing what in all these samples is but what is understood as a chip coming from a light roughing cut, the coiled chip having but little width and considerable thickness.

The shavings exhibited by Krupp, however, have very different and most extraordinary proportions, and such as will appear to the most expert turner of metals as beyond any thing they would dream of as possible; and they not only testify to the toughness of the metal of which they are composed in fully as high a degree as do the Swedish samples, but also establish the fact that they must have been produced by machines of remarkable rigidity and strength.

These shavings are very thin, not thicker than good stout paper, but are in one case 25 feet, and in the other 24 feet 6 inches long, and both $10\frac{1}{4}$ *inches wide*. They have evidently been produced by a flat-faced spring tool, such as are ordinarily used for light finishing cuts, with a very rapid or coarse feed, having a width or length of cutting edge not less than $10\frac{1}{4}$ inches. They are crumpled and fluted like a lady's frill, just as this kind of shaving always appears when taken from malleable metals with the broad-faced spring tool, and would no doubt be about double the length they now measure if straightened out perfectly flat. They were made while taking a finishing cut over one of Krupp's large steel cannon. They have been, together with a large part of the smaller articles in the Krupp exhibit, donated to the Smithsonian Institute at Washington. They are, without doubt, by far the widest and longest specimens of this peculiar kind of shaving ever made, and a most decided curiosity.

J. T. H.

CLOSING CEREMONIES OF THE CENTENNIAL INTERNATIONAL EXHIBITION OF 1876.

ACCORDING to previous announcement, the formal closing of the Exhibition took place November 10th, 1876.

By one o'clock Judges' Hall was well filled with guests, among whom were many ladies, and shortly before two o'clock the First City Troop, Capt. Fairman Rogers, about forty strong, and in full uniform, and who were detailed to act as body guard to President Grant, entered the hall, and were drawn up in line at the eastern end of the hall.

A platform, capable of seating a limited number of persons, was erected at the northern end of the hall, and the gallery was occupied by Theodore Thomas and his orchestra of 110 performers, and the chorus, consisting of 450 ladies and gentlemen, selected from all the vocal societies in Philadelphia.

President Grant and Secretary of State Hamilton Fish entered Judges' Hall shortly before two o'clock, and were escorted to Gen. Hawley's rooms, where they remained until the exercises commenced.

A few minutes past two o'clock the First City Troop were formed in line in the hallway leading to Gen. Hawley's room, and shortly afterwards the Presidential party proceeded to the platform in the Hall in the following order, the First City Troop receiving the party with open ranks and sabres at a present:

Reception Committee: Gen. McNiell, of Missouri, Chairman; Col. Bolder, of West Virginia; Col. John Price Wetherill, of Philadelphia; N. Parker Shortridge, of Philadelphia; Judge Lynch, of Louisiana; E. T. Steel, of Philadelphia; Gen. Gurney, of South Carolina; and Gen. Parsons, of Alabama.

President Grant and General Joseph R. Hawley.

Secretary of State Hamilton Fish and Mr. John Welsh.

Secretary of War Cameron and Alfred T. Goshorn.

Hon. D. J. Morrell, Gen. Robert Patterson, and Mr. George W. Childs.

On arriving at the platform, the front and centre seat was occupied by President Grant, and on his right sat General Hawley, Alfred T. Goshorn, Secretary of War Cameron, and Mr. George W. Childs; and on his left were Secretary of State Hamilton Fish, Hon. D. J. Morrell, Rev. Joseph A. Seiss, Mr. John Welsh, Mrs. E. D. Gillespie, and General Robert Patterson; and in the rear of the above, and on the platform, were Governor Hartranft; Governor Rice, of Massachusetts; Hon. Thomas A. Scott, Hon. Asa Packer, U. S. Grant, Jr., Mayor Stokley; Governor Bedle, of New Jersey; Chief-Justice United States Supreme Court, Morrison R. Waite; Assistant Justices David, Davis, and Bradley; Sir Edward Thornton, British Minister; Hon. Nathaniel P. Banks, of Massachusetts; Governor Cochran, of Delaware; Bishop Simpson, Bayard Taylor, ex-Governor E. A. Straw, of New Hampshire; Fred. Fraley; the Belgian, French, Turkish, Tunisian, and other Centennial Commissioners; T. Saigo, Japanese Imperial Commissioner; Aristarchi Bey, Turkish Minister; S. M. Felton; Prof. Blake, of the Smithsonian Institute; John L. Shoemaker, and others.

The ceremonies opened with the performance, by Theo. Thomas' orchestra, of Wagner's Grand Inauguration March, after which an eloquent prayer was offered by the Rev. Joseph A. Seiss, of Philadelphia.

The chorus, accompanied by the orchestra, then sang in fine style a choral and fugue by Bach.

General Hawley then introduced the Hon. D. J. Morrell, United States Centennial Commissioner from Pennsylvania, and Chairman of the Executive Committee, who delivered an appropriate address.

Selections from the "Dettingen Te Deum" were then sung by the chorus, after which the Hon. John Welsh, President of the Centennial Board of Finance, was introduced. Mr. Welsh was received with loud and long-continued applause, and he spoke as follows:

SPEECH OF HON. JOHN WELSH.

Fellow-Citizens: In this closing scene of the International Exhibition I may well give expression to the grateful emotions which swell my heart, that all who have shared in the labor of its preparation and conduct, in your approval of it, meet their coveted reward.

The predictions of evil which were made of it—and by many in high places—have not been realized. The nation has not been dishonored. The good name of its people has not been imperilled. This day witnesses that the noble purpose of its projectors has been accomplished.

It has hallowed the Centennial year by an inspiration of the past. The circumstances attendant on the nation's birth have been recalled. The patriotic impulses of the people have been quickened. Their love for their country has been strengthened.

The Exhibition has concentrated here specimens of the varied products of the United States, and made better known to us our vast resources.

It has brought to us the representatives of many nations, men skilled, accomplished and experienced, and they have brought with them stores of treasures in all the forms given to them by long-practiced industry and art. And others are here from new lands, even younger than our own, giving full promise of a bright and glorious future.

It has placed side by side, for comparison, the industries of the world. In viewing them, the utilitarian revels in the realization that man is striving earnestly to make all things contribute to his convenience and comfort; the philosopher stands in awe at their contemplation as he dwells upon the cherished thought of the possible unity of nations; and he who looks on the grandeur of the scene from a spiritual standpoint is filled with the hope that the day is near "when the

glory of the Lord shall cover the earth as the waters cover the sea."

It has taught *us* in what *others* excel, and excited our ambition to strive to equal them.

It has taught others that our first century has not been passed in idleness, and that, at least in a few things, we are already in the advance.

It has proved to them and to us that national prejudices are as unprofitable as they are unreasonable; that they are hindrances to progress and to welfare; and that the arts of peace are most favorable for advancing the condition, the power, and the true greatness of a nation.

It has been the occasion of a delightful union among the representatives of many nations, marked by an intelligent appreciation of each other, rich in instruction, and fruitful in friendships.

It has placed before our own people, as a school for their instruction, a display—vast and varied beyond precedent—comprising the industries of the world, including almost every product known to science and to art.

It has made the country and its institutions known to intelligent representatives of all nations. They have had access to our homes, have become familiar with our habits, have studied our systems of education, observed the administration of our laws, and will hereafter understand why the United States of America exerts so large an influence on other nations, and consequently the great truth that in proportion to the intelligence and freedom of a people is their loyalty to their government.

It has concentrated on this spot, in the short term of six months, eight millions of visitors, who have enjoyed all its rare privileges without a disturbance, or any personal hindrance from violence, or even rudeness.

It has exhibited the American people in their true character, respectful of each other's rights, considerate of each other's convenience, and desirous of allowing to others a full participation in their enjoyment.

It has afforded an opportunity to show that the administration of an exhibition on a grand scale may be liberal in its expenditure without useless extravagance; that its laws may be strictly enforced with impartiality and without harshness; that its regulations may secure the efficiency of its departments and uniformity in their action; that its whole course has been free from financial embarrassment or even a payment deferred; and that, notwithstanding every part of its machinery was in constant motion, no one of the immense throng within the limits of the Exhibition was sensible of its restraint.

It has shown that the authorities of the great city in which the Exhibition has been held have been actuated by a single eye to the promotion of the public convenience; that, under their supervision, facilities of every kind have been provided, property has been protected, good order has been preserved, unusual health has prevailed, and extortion in its varied forms has been almost unknown; these, combined with the unlimited accommodations for visitors, and the hospitality of its citizens, are in beautiful harmony with the purposes of the Exhibition. Nor has the State of Pennsylvania been less in sympathy. The traditions connected with its soil are its priceless heritage.

The International Exhibition is to be regarded as a reverential tribute to the century which has just expired. That century has been recalled. Its events have been reviewed. Its fruits are gathered. Its memories are hallowed. Let us enter on the new century with a renewed devotion to our country, with the highest aims for its honor, and for the purity, integrity and welfare of its people.

On the Exhibition the curtain is now about to fall. When it has fallen, the wonderful creation, in the beauties of which we have so long been revelling, will have passed away. Looking round upon it now, while the scene still glows with its grandeur, and our senses are rejoicing in its delights, I desire to assure all who have contributed towards its production that there is at least one who bears in grateful remembrance whatever they have done. It may have been an humble prayer, the earnings of hard toil, out of their abundance, or the devotion of years of intelligent labor—it matters not. The little brooks and the rivers alike make up the mighty ocean. To all—at home and abroad—who have helped us forward; to the sovereigns and governments of other countries who have countenanced and encouraged us; to their representatives who have worked so nobly in our cause; to the exhibitors of our own and other lands, who have done more than can be expressed; to the Congress of the United States of America, for its generous and timely aid; and especially to the President of the United States of America, for his unwavering support and encouragement, are due the grateful acknowledgments of the nation. Would that I were authorized to make such acknowledgments here, or that my own had the value in them to make them acceptable to them all, from the humblest to the highest.

And now to my fellow-laborers of the United States Centennial Commission, and of my more immediate associates in the Centennial Board of Finance, I need only say that our work has its place in the annals of the nation. If the memories of it be pleasant to our countrymen, we have done well.

The orchestra then performed the fifth symphony of Beethoven in admirable style, after which the Hon. A. T. Goshorn, Director-General, was introduced, and delivered an address.

The chorus, with splendid effect, then sang the Hallelujah Chorus from the "Messiah."

The Hon. Joseph R. Hawley, President of the Centennial Commission, then appeared, and addressed the assemblage, closing as follows:

The concurrent and almost wholly harmonious testimony of our citizens, at home and abroad, permit us to feel that we have, on the whole, been largely successful in all our work. This commendatory judgment is very grateful to us. My associates have given expression to our gratitude. I would gladly add to what they have said if I could. The Commission thanks the city of Philadelphia, the State of Pennsylvania, the National Government, and especially you, sir, our honored President. It thanks the Foreign Commissioners, one and all, most heartily. It thanks the exhibitors of all nations. It thanks the American people, whose conduct here has commanded unbroken respect. It thanks warmly its associate corporation, the Board of Finance. Above all, it reverently acknowledges the kind favor of Heaven, which has so smiled upon us that while we turn somewhat sadly from these scenes of great labor and greater pleasure, all who have been associated here may feel that they have done something towards advancing the world to the better day coming. God be praised for the past! God send us all, individuals and nations, a happy future.

Mr. President, we await your pleasure.

The chorus then sang the hymn, "America," the words of which are as follows:

"My country, 'tis of thee,
Sweet land of liberty,
Of thee I sing;
Land where my fathers died;
Land of the pilgrims' pride,
From every mountain side
Let freedom ring!

Our fathers' God, to Thee,
Author of liberty,
To Thee we sing;
Long may our land be bright
With freedom's holy light;
Protect us by Thy might,
Great God, our King."

During the singing of the above hymn, the original flag of the American Union, first displayed by Commodore Paul Jones on the "Bonhomme Richard," was displayed on the wall of the Hall behind the platform, and the audience arose and joined in the singing.

General Hawley then advanced and announced that President Grant would formally declare the Centennial Exhibition closed, and would give the signal for the stoppage of the Corliss engine, in Machinery Hall.

President Grant then arose and was received with the most enthusiastic applause. After bowing his acknowledgments, he simply said, in a low tone of voice, "I now declare the Centennial International Exhibition of 1876 closed." The President then turned to the left and gave a wave of his left hand (the signal for the stoppage of the Corliss engine), and at the same instant the operator of the telegraphic instrument temporarily stationed on the platform, dispatched the word to those who were waiting to receive it in Machinery Hall, and the great engine ceased to work at 20 minutes of 4 o'clock.

The chorus and audience then joined in singing the Doxology, "Old Hundred," and the closing ceremonies were over.

THE GREAT EXHIBITION OVER.

"I NOW declare the Centennial International Exhibition closed," were the words spoken by the President of the United States on November 10th, to mark the ceremonial conclusion of the grandest exposition of industry, art and progress the world has ever seen. As the words were pronounced a concerted signal, flashed by wire from Judges' Hall to the centre of Machinery Hall, stopped the colossal engine. Amidst the pealing of bells and gongs and the salutation of steam whistles and trumpets, that great pulsating iron heart of Machinery Hall ceased to beat. Moved by an instinctive impulse, there was an attempt on the part of the multitude to cheer, but there was more sadness than gladness in the emotion, and what was designed for a hurrah came very near breaking down into a sob. It would have taken very little more to have brought moisture into the eyes of most of those who surrounded the great engine as the mighty wheel ceased to revolve.

Another wire near the President touched by the operator at the same moment sent the formal announcement of the close of the Exhibition over the country, and of the conclusion of the six months' celebration of the hundreth anniversary of American Independence. And who is there now who is not ready to say that the celebration has been most worthy of the country, adding to its fame and its credit throughout the world, and that it has been in the highest degree a satisfactory celebration to the people of the United States? The eight millions of people who passed through its gates as paying visitors have given it their unstinted homage. It received, in all, more than nine million six hundred and sixty thousand visits during the one hundred and fifty-nine days it has been open—a greater number than ever attended an Internatiomal Exhibition in the same space of time. All honor and thanks to the faithful, devoted, unselfish gentlemen who have given to it their time, their energies, and their talents. Those of them to whom this sentence applies with fitness and all the emphasis with which the acknowledgment can be made should never be forgotten by their fellow-countrymen.

Beset from the very outset by difficulties and obstructions; supported for more than three years only by the will, the indomitable persistence and abounding faith of the people of Philadelphia and Pennsylvania, it was never clear of some sort of embarrassment until it bloomed upon the world a grand and magnificent success. It is now enshrined in the affections of millions and millions of the American people. No influence can efface the pleasure and satisfaction and pride with which it has been seen and enjoyed; and it will endure throughout the lifetime of the generation which saw it and knew it as a beautiful, patriotic, and cherished memory.—*Phila. Ledger.*

IMPROVEMENT IN POSTAGE-STAMPS.

By Prof. H. VANDER WEYDE, of Brooklyn, N. Y.

I HAVE the postage-stamps printed with pigments which will resist dryness and moisture, cold and light, but not heat, as they will totally volatilize at a temperature of from 212° Fahrenheit, the boiling point of water, to 300° or 350° Fahrenheit, a temperature not high enough to injure or even change any ink, writing-fluid, aniline, etc., or even vegetable coloring matter.

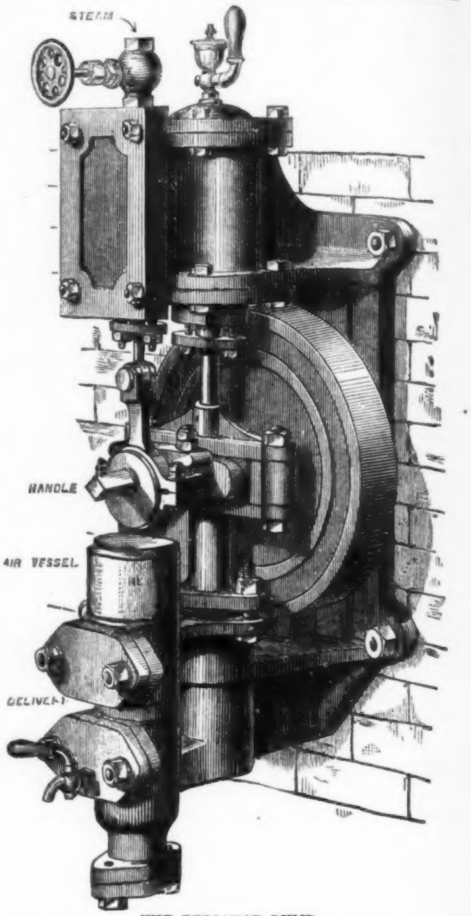
Fortunately modern chemistry has taught us the knowledge of many colored solids which will evaporate at that temperature, and all that we have to do is to have the postage-stamps printed with such substances, when they will remain unchanged any length of time, until at last, when affixed to letters and dropped in the post-office, they are then simply thrown in a box, heated by a steam-coil or other suitable means to the temperature of 300° Fahrenheit, more or less, and left there for the space of a few minutes, when the whole figure of the postage-stamp will have become obliterated by volatilization.

The substances which can be used for this purpose are biiodide of potassium for scarlet, realgar for dark red, orpiment for yellow, red iodide of mercury, some colored cyanides and fulminates. All permanent colors may also be used, especially when, for the purpose of printing, they have been mixed with a protective mucilage or varnish-like substance, as a solution of shellac in borax solution, etc. Fixed oils form a protecting material, which would tend to prevent volatilization, except when we make use of some volatile ethereal oils and resinous substances, which would only protect the volatile coloring matter against the usual agencies of moisture, etc., but volatilize with the pigment at 300° Fahrenheit. Some intermixtures also affect the disappearance by heat as a mixture of cyanide of mercury with bi-iodide of mercury, or the sulphide of arsenic with the sulphide of cyanogen; further, the iodides and bromides of cyanogen and mercury, etc.

In order not to destroy the denomination of the stamps, in cancelling them, I print them with two different inks—one to indicate the monetary value—which ink is of the ordinary kind, or any other ink indestructible by heat, and the other for the remaining portion of the design, consisting of one of the substances above described, volatilizable by heat. When the latter is destroyed by the heat the stamp is considered cancelled, notwithstanding the primitive value is still visible.

SYERS' "RELIANCE" PUMP.

THE accompanying engraving illustrates a neat little pump recently brought out by Messrs. P. R. & A. E. Syers, of Manchester. The cylinder, valve chamber, and air vessel are cast in one piece, and are bored out in one setting. The piston and valve rods are of steel, and they work through gun-metal glands. The pump valves and seatings are of gun-metal, and the ram works through a brass bush. The valves are all readily accessible. This pump is extremely convenient for



THE RELIANCE PUMP.

readily filling boilers which have been standing or blown out. When used for this purpose, a winch is fitted on to the crank shaft at the part shown in the cut, and the pump may then be worked by hand.—*The Engineer.*

HAND ROCK-DRILLING MACHINE.

THE boring machine which is represented in the accompanying illustration is manufactured by Messrs. H. B. Barlow, Jr. & Co., of Manchester, and adapted mainly in all cases in

HAND ROCK-DRILLING MACHINE.

which only a limited number of bore holes is required per day, and in which the application of compressed air or steam as motive power would be too expensive, or for other reasons inadvisable. These machines are therefore of advantage in places where labor is cheap, or where the employment of large

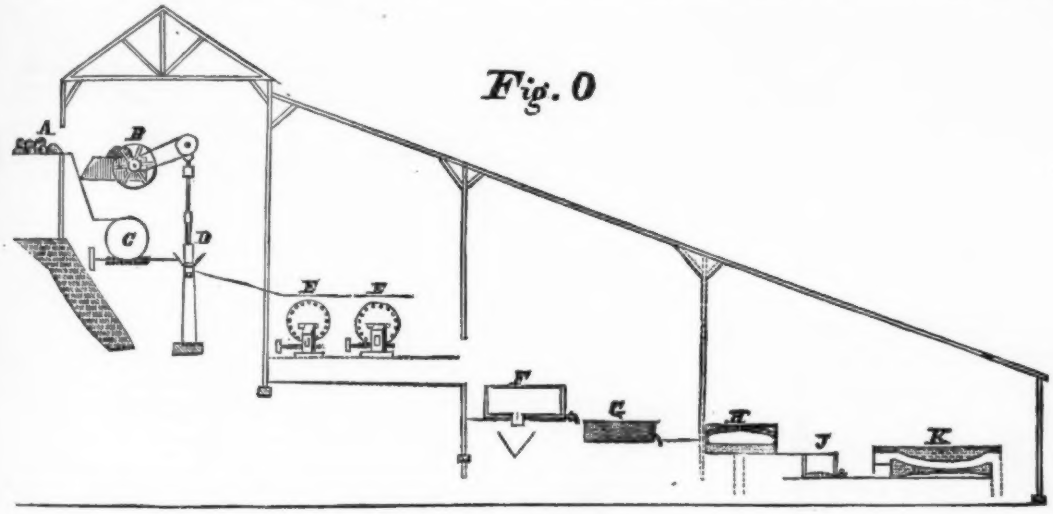
capital for working on a larger scale would not be remunerative.

The machine consists of a triangular base frame, that rests on the ground by means of adjustable supporting pins. The guide frame for the borer is pivoted to a horizontal shaft of the base frame for the purpose of admitting the boring at any suitable angle, in connection with an adjustable rear brace. The borer is operated by means of a crank shaft and transmitting gear wheels, which actuate the oblong frame to which the borer is attached. The power is imparted by a strong leaf-spring, in analogous manner as in the case of the well-known spring hammers. The cutting tool is driven into the bore-hole by a sliding hammer, which is attached by leather straps to the strong leaf-spring. Simultaneously with the reciprocating motion of the boring tool, an intermittent rotary motion is given to the same by ratchet and pawl mechanism, as in the customary hand-boring machines. The length of stroke of the borer is increased by the actuating spring from $1\frac{1}{4}$ inch to 5 inches and the transmitting gearing is so arranged that 40 revolutions of the hand crank produce 212 blows of the hammer. For quarries, coal and other mining purposes, the boring machine may be employed with advantage, as it may be used in sections in which larger boring machines may not be put up; the machine may also be shipped, on account of its compactness, with great facility.

THE MONNIER PROCESS.

THE Monnier process has lately been introduced in Nevada County, Cal., and considerable interest is manifested in it. This process has been heretofore introduced at a number of establishments with considerable success, so that is no experiment. It was originally intended principally for working copper ores, but is adapted to the treatment of a wide range of ores.

The Monnier process consists, substantially, as follows: 1. Calcination of the metallic sulphides with a portion of sulphate of soda, or other similar salt. 2. Lixiviation of the calcined ore. 3. Evaporation and crystallization of the sulphates. 4. Reduction of the sulphate of copper. 5. Smelting into ingot copper. 6. Amalgamation of any gold residuum. The working details are substantially as follows:



THE MONNIER PROCESS.

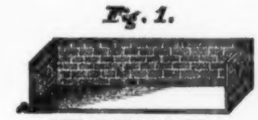


Fig. 1.

THE CRYSTALLIZER.

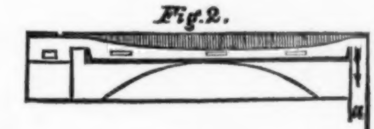


Fig. 2.

THE EVAPORATING FURNACE.

The ore is mixed with sulphate of soda and crushed fine enough to pass through a No. 24 screen. It is next roasted in a muffle furnace or a revolving cylinder furnace; the sulphur will begin to burn within an hour after the introduction of the ore, and after that time but little fuel is needed until toward the end of the roasting. Sulphuric acid is formed by the oxidation of part of the sulphur, while the larger proportion of the sulphur escapes as sulphurous acid. The iron, copper, and silver are converted by the sulphuric acid into sulphates, and the sulphate of soda into a bi-sulphate. Soon all the sulphur not combined with the soda or metallic oxides is expelled. A low red heat is now reached, and the sulphates of iron and copper suffer decomposition. The sulphuric acid at first combined in this form has been stored up, and is now evolved by the greater heat. Being nascent, its combining power is of intense activity and force, and it attacks any and all metallic oxides or sulphides remaining uncombined, converting them with great rapidity into sulphates. The copper and silver present are soon converted into soluble sulphates, iron oxide and gold remaining unconverted and insoluble. In this latter stage of the roasting, the value of the sulphate of soda becomes apparent; it holds fast to the excess of sulphuric acid formed during the early stage, and carries it on to this critical point. While by other methods of roasting to sulphates, only a portion of the metals are retained as sulphates, and the balance is reduced to an insoluble form, by this method the acid is retained until required by the copper and silver, when it is given up at the right time, and those metals are recovered with great ease. If the saving of the sulphuric acid evolved should be of consequence, the gases from the furnace may be led into the usual lead chambers.

The roasted ore is next placed in tanks and lixiviated with cold water. The use of hot water is to be avoided, as it would dissolve a greater quantity of base metal sulphates, notably those of lead and antimony. The leaching water, highly charged with copper, silver, and soda sulphates, is conducted into tanks containing cement copper, on which the silver is precipitated in a metallic form as cement silver, whence it may be recovered by the usual methods.

The large amount of sulphate of soda present in the liquor must now be recovered and regenerated for future operations. To effect this, the solution is run into crystallizing tanks, and left for several days, when most of the soda will crystallize out. See Fig. 1. The crystallization is interrupted before the sulphate of copper begins to deposit; and the solution is run into an evaporating furnace. See Fig. 2. In this, the hearth is a wooden box lined with lead; *a* is the flue. This is only moderately heated. It receives a steady supply of liquor to maintain a constant level. In this furnace the sulphates of soda and copper, as they crystallize, are raked out, while the final charge is evaporated to dryness. Some 60 per cent of the sulphate of soda originally present is obtained from the first crystallization, which, as soon as it is drained and dried, is ready to go the round again. The 40 per cent balance is not lost, but is recovered in a following operation.

The dry sulphates of copper and soda are next mixed with charcoal and heated in a reverberatory furnace. As soon as fluidity is attained, sulphurous acid is evolved. The mixture is gradually heated to redness, at which temperature it is kept until all the sulphurous acid is expelled. The sulphate of soda remains undecomposed, and the sulphate of copper is converted into a mixture of red oxide and metallic copper.

The calcined mixture, when cold, is washed in a tank of water, where the unburned coal and soda are easily separated. The soda being again in solution may be run into a crystallizer and completely recovered. The copper is now ready for the refining furnace, which refining does not differ from the ordinary process, Fig. 0. In this engraving A represents the ore; B, Blake crusher; C, cylinder ore drier; D, stamps; E E, Bruckner cylinders; F, lixiviator; G, crystallizer; H, evaporating reverberatory furnace, end view; I, washing tank; K, reducing furnace.

The plant of the Monnier process costs but little. For complex copper ores probably no establishment could be built on any other plan with a less amount of capital. About a week is required for the passage of the ore and products through the various operations. It is estimated that ingot copper can be produced in a works of this nature from a ten per cent ore for five cents per pound; which is considerably cheaper than by the English or German plans of fusion. Very little skilled labor is required. The use of metallic iron for the precipitation of the copper is avoided by the use of sulphate of soda and the method of reducing the sulphate of copper. The soda is used continually with but little loss. Wear and tear are very small, as only low heats are required. The process enables all the valuable metals in the ore to be extracted, while the sulphur can be converted into sulphuric acid. The concentration of poor ores is not so obligatory as in the fusion processes and poorer ores can be worked. During the roasting it is probable that a double salt of soda and copper is formed, which helps to keep the copper in a soluble form. The washed copper has almost the exact appearance and richness of cement copper precipitated by metallic iron, and undergoes the same species of refining. The actual consumption of soda does not exceed one per cent for each operation. The loss of copper is not more than five per cent, and may be even less with good management.

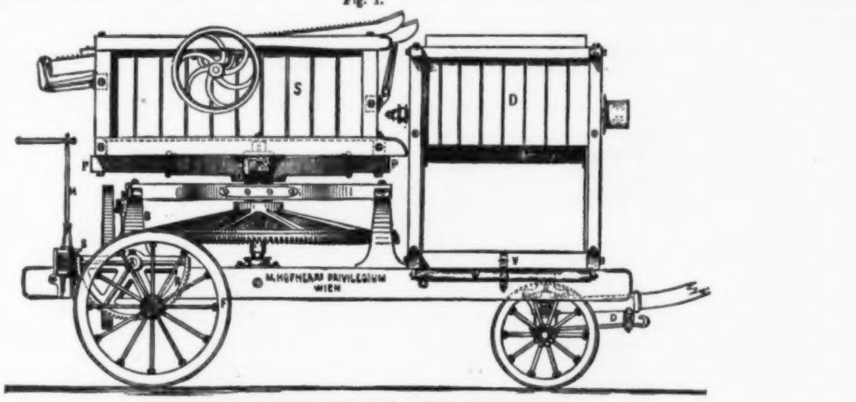
A weak point in the Monnier process, as well as in some others, is that it requires considerable fuel to evaporate its solutions, and in a country where fuel is high priced and inferior, that may be a serious disadvantage. But, however that may be, it is probable that, where the ores are rich enough to bear beneficiation by any process, nothing has ever been discovered which will do its work cheaper and cleaner than the process of Monnier, just described. It saves the silver and copper as well as the gold that may be in the sulphurets. At the Providence mine, in Nevada county, it is applied specially for working the sulphurets. We have had no opportunity of learning what changes they may have introduced there for their special object, but the full process is as described above.—*Mining and Scientific Press.*

PORTABLE HORSE-POWER AND THRESHER.

LARGER threshing machines are frequently constructed on trucks in connection with horse-powers for being transported from place to place. The supporting part or body, resting on the trucks, forms in such cases the base frame of the machine. The objection to these portable horse-power threshers was mainly due to the difficulty connected with the setting up of the power and thresher, as a large number of hands was required to lower them from the trucks and replace them thereon. Sometimes the trucks remain attached to the power and thresher, and are placed into excavations of the ground, which, however, takes up considerable time.

Mr. Hofherr, in Vienna, has constructed a portable power and thresher that avoids the difficulties mentioned in a very simple manner. The power and thresher is shown in Fig. 1 as packed for transportation, while Figs. 2, 3, and 4 show the method of lowering the same for use. The thresher is arranged on the trucks in front of the horse-power, above which the straw-shaker is placed after being detached

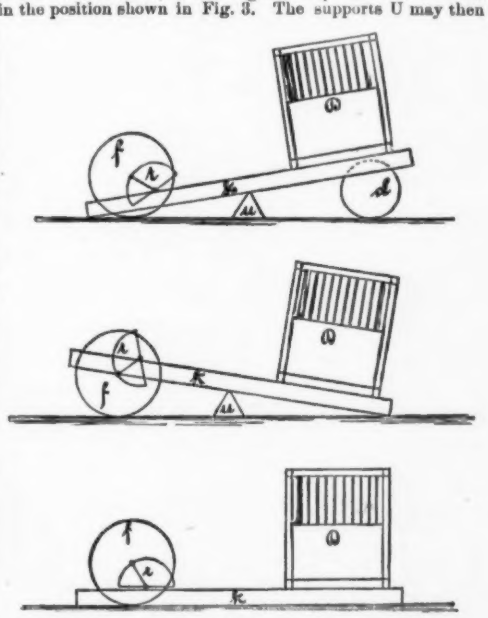
Fig. 1.



PORTABLE HORSE-POWER AND THRESHER.

from the thresher. The supporting frame of the trucks is provided at the rear part with semicircular gear wheels R, whose shaft A swings in bearings of the base frame. At a point of the circumference of the gear wheels R, where the radial braces stiffen the same, are fixed pivot shafts N for the hind wheels F. The gear wheels are turned by means of a worm wheel, with hand lever or wheel.

If it is desired to lower the thresher and power for working the same, the pointed supports U are placed vertically below the centre of gravity that is marked on the supporting base frame. The worm wheel is then turned until the base frame assumes the position shown in Fig. 2. In this position the front wheels may be removed by withdrawing the king-bolt. The worm-wheel is next turned in the opposite direction so as to lower the wheels again and place the base frame in the position shown in Fig. 3. The supports U may then



PORTABLE HORSE-POWER AND THRESHER.

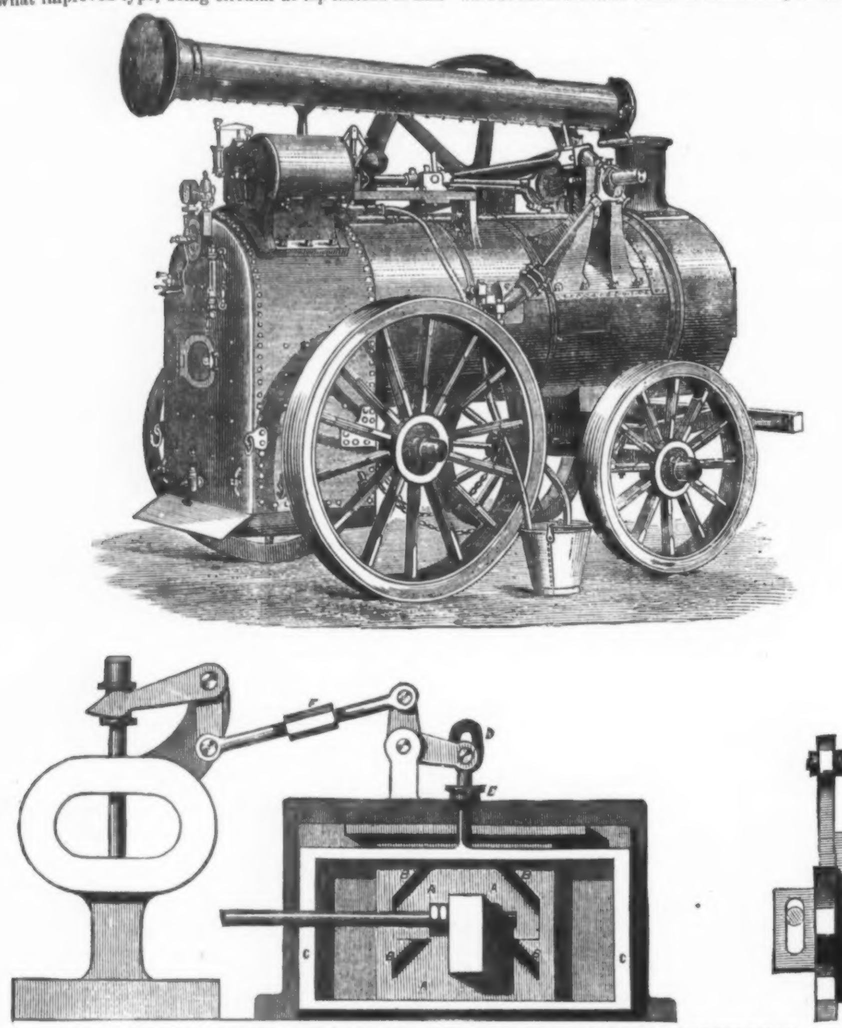
be removed and the base frame lowered entirely by swinging up the wheels, as shown in Fig. 4. When it is desired to make the power and thresher portable, the same operation is followed in reversed order.

When the frame is on the ground, the shaker is taken off the power and connected to the thresher in the customary manner, the machine being then ready for instant work, requiring only two hands to be lowered or raised again for transportation.

PORTABLE ENGINE AND NOVEL VALVE GEAR.

In the accompanying engraving we illustrate an eight-horse-power portable engine, with variable expansion gear, constructed by Messrs. Armitage and Ruston, Chatteris, Cambridge.

The valve gear is somewhat peculiar, and will be readily understood from the accompanying detail drawing. On the back of the main slide B is worked a cut-off slide A; the steam admission ports are inclined, and the cut-off slide being raised or lowered by the governor by means of the bent levers and coupling rod F, the point of cut-off is controlled by the governor in a way which is sufficiently obvious. The arrangement is very simple, and we understand gives good results in practice. The fire-boxes of these engines are of a somewhat improved type, being circular at top instead of flat.



EIGHT-HORSE POWER PORTABLE ENGINE, WITH NOVEL VALVE-GEAR.

The engines are well designed and good of their kind, but the most notable feature about them is the valve gear.—*The Engineer.*

THE MEN WHO "KNOW IT ALL."

There seems to be something about the occupation of a railroad man which intensifies personal character. We have seen arbitrary men grow more dogmatic and inflexible year by year, and meek men who became more plastic the longer they were subject to authority, prompt men who grew to be as imperious as Napoleon, exact men whose methods ultimately would have done credit to scientific research, lazy men who by practice learned constantly how to do less, industrious men whose intentions were stronger than their power of fulfilment and who ultimately succumbed in health and strength, visionary men who dreamed fresh dreams and more of them month by month, conservative men who shrunk from season to season with a sort of envelope of unimpressibility like a caterpillar into its cocoon (leaving us sceptics, however, whether they would ever emerge butterfly fashion), sanguine men for whom the future was always drawing compound interest on the past, honest men whose scruples grew more strict as their lives lengthened, dishonest men who received more and bigger bribes as they grew older, wise men who learned wisdom with their experience, profane men who swore oftener and more irreverently the longer they were employed on railroads, ignorant men whose minds seemed to grow more dense the longer they fulfilled the duties of their calling, and conceited men whose knowledge and wisdom in their own estimation far surpassed that of all the philosophers and sages. It is this latter class to which we wish to give a little attention—the class whose conceit, coupled with dense ignorance, obstructs all the avenues which lead to improvement, and who, if they could, would snuff out all the lights of knowledge excepting their own prescience, and make bonfires of libraries and barbecues of philosophers. So self-satisfied are they in their own conceit that a suspicion of their own ignorance never dawns on them; but, to employ a common phrase, "they think they know it all." There is something exceedingly hopeless about this state of mind. You talk to such men about the advantages of the improved form of rail sections with comparatively thin web or stem, and they will say, "I don't like it," as if their likes and dislikes were the final court of appeal in such matters. So wrapped up are they in their own opinions that they do not seem able to conceive that there may be reasons and causes which determine what is right or wrong, good or bad, quite distinct and separate from their own self-consciousness. If you gently ask for reasons for their faith, or rather prejudice, against the form of rail, they may venture the guess that the web is too weak and that the rail will bend over. If you demur and say that many miles of such rails are in use and no such trouble has been experienced, or if you refer him to experiments which have been made with rails having much thinner webs and show him that these were still stronger than the resistance of the spikes, and that before the web would bend or break, the spikes could be drawn out, he will tell you that such may be the case in theory, but in practice it is different. At this stage of the argument the man who "knows it all" will usually not hesitate to say what is not true in order to defend his own position, and will tell you that he has seen plenty of such rails which had given way laterally, and that at any rate if they do not do so they will, and even if they don't, they are too weak in the head and will splinter off on the side. You mildly suggest that while this may have been the case with some of the first forms of such rails, the heads of which were not deep enough, but were made very convex on the side, so that with iron imperfectly welded such rails did splinter off, but that with more recent forms, the heads of which were deeper and flat on the sides and the rails made of better material instead of bad iron, no such difficulty existed. He will then probably lead you to a pile of old rails, and show you triumphantly specimens of just such rails as you have described made of the poorest iron and torn into shreds by hard usage. "There," he says, "are your new-fangled rails." "There," you say, "are the old and imperfect forms made of bad material." "They have done just what I said they would," he says, while you protest that they are not a good pattern or good material; and he ends as he began by a proclamation that he "don't like 'em."

If you talk about locomotives, and suggest that their improvement in economy of fuel and performance generally has not kept pace with the improvements which have been made in marine and other engines, he will quite likely say that the reason is because railroad companies will not use his patent grease-pot. "You see it takes too much power to overcome the friction. Things is not lubricated right, but *my* grease-pot just puts the oil where it is needed and saves all that is not needed." If inclined to be argumentative and at the same time conciliatory, you may say to him that probably his grease-pot is a good thing, but that you think there are other sources of waste, such as loss of heat by radiation, the use of wet steam and impure water, and imperfect combustion, whose aggregate amount is greater than that which could be saved by greasing properly. It might also be suggested to him that a great deal might be saved by keeping an accurate account of fuel consumed by each engine, thus enforcing greater care and economy in the management of engines. Now, to such suggestions, the man who knows it all is quite invulnerable. He don't believe it pays to keep an army of clerks to keep accounts of the fuel used; "besides, what is the use? it must be paid for just the same whether you keep an account or not, and it is just as well to save the money it costs for clerk hire. As for locomotives, you can't teach him nothing; he knows about them practically; he has run engines and knows what they can do. Theories are all nonsense; he can tell what a locomotive will do without any of your theories."

If you talk about signals, he will ridicule all the recent improvements, and tell you that the interlocking system of switches is too complicated for practical use, and costs more than it comes to, and the block system is all a humbug. "If a man hasn't sense enough to keep out of the way of other trains, it is better to discharge him and get good men who know what they are about. This signal business, any way, is all a humbug. Them Englishmen better come over here and learn how to run a railroad, instead of talking to us about their dam signals."

The man "who knows it all" has an unlimited amount of such talk. His chief characteristics seem to be a contempt for what other people know, and a very exaggerated idea of the value and correctness of what he knows himself. It is quite difficult for any one engaged all his life in learning, to realize the true state of the mind of the man "who knows it all." Such men are seldom entirely stupid. They have a sort of aptness to learn from what they see, but unfortunately they seem incapable of realizing that other people have also been seeing and learning as well as they. Then, too, it is probable that such persons are deficient in imagination. They can not conceive of the existence of knowledge of which they are ignorant. They seem to feel about it as children do about the question whether the fall of a tree in a wilderness, with no one within hearing distance, produces any sound, so our knowing friend does not seem capable of conceiving of knowledge which *he* does not know, and in this way what he learns he comes to regard somewhat as though he were the original inventor or discoverer of it. He reasons in this way: "If I know a thing, it is true; what I do not know is all humbug."

One of the causes which produce this condition of mind is the fact that such persons usually acquire information only by personal observation. They seldom are reading men or accustomed to accept information on the testimony of others, and this fact implies a certain amount of incredulity. It is true that we all acquire more or less of this with experience and age, but those who seek knowledge, and are always loyal to the truth, acquire with experience more or less discernment, which enables them to distinguish true testimony from that which is false, and therefore the effect is to lead them to read and to hear more testimony rather than less, in order that they may find more grains of real value, although they may be, as we all are, obliged to reject vast quantities of chaff. The man who "knows it all" finds it much easier to make a sweeping generalization and declare all other knowledge than his own folly, and is more content in the contemplation of his own wisdom than in learning from others.

There is but little hope for a person who has reached mature life with the conviction that he "knows it all." Early education usually is a cure or preventive, but nothing but a sentence to hard labor for the rest of his days will save society from the ills which the man who "knows it all" can inflict on those compelled to come under his influence.

It may be set down as a good rule in appointing an officer on a railroad or elsewhere to ask first whether he "knows it all." If he does, reject him, because a man's capacity and willingness to learn form a very important qualification to enable him to command wisely, and no one man ever knows or can know so much as not to be obliged constantly to learn more. A good question to ask about a candidate for a position of responsibility is, What capacity has he for *acquiring* knowledge? because if he thinks he knows it all, he will gradually become less instead of more efficient and useful as he grows older.—*Railroad Gazette.*

METALLIC RAILWAY CARS.

The time is evidently approaching when iron will be used much more extensively in the construction of cars than it is at present. There are two principal reasons for this—namely, the increased cost of timber, and the necessity for lighter, cheaper, and more durable cars, especially for freight service. In the construction of freight car trucks, iron has already taken the place of wood to a very considerable extent. Its use in this respect has ceased to be an experiment, the question of economy having been determined in favor of iron by some of the best railroad mechanics in the country. If properly constructed, iron trucks weigh no more than wooden ones, and are even lighter than some of the latter kind in use on many important roads. They can be framed and erected with less labor, and with a cheaper kind of labor. The material, as compared with wood, being nearly indestructible, there is consequently less outlay for repairs; there are fewer pieces, and less liability to warp or shrink. These points have been pretty well established as regards iron trucks both for passenger and freight cars; but as respects car bodies made exclusively of iron or steel, a prejudice will no doubt exist so long as timber costs no more than it now does, and so long as the greater economy of such construction is not demonstrated so clearly by actual performance as to overcome all doubts.

Many attempts have been made to construct metallic car bodies for the purpose of testing their economy and practicability, the most noteworthy of which are the platform cars recently built for some Eastern roads, upon the well-known plan of Dr. La Mothe. This plan consists in the use of steel rods and iron tubing, fastened together in such a way as to make the framework a perfect unit, without joints, mortices, tenons, or rivets. It is also asserted by the builders of these cars, that freight box cars, with steel trucks, and weighing only 20,000 pounds, can be built upon this plan, that will safely carry 25 tons of freight. This, however, is a special style of construction which has its peculiar merits. The use of channel iron for the longitudinal parts of the floor framing has been tried, we believe, with very good results. Indeed, iron cars of various styles, sizes, and patterns have been built and used in this country and in Europe, and although they have not been so entirely successful as to definitely settle the problem in favor of this material for bodies as well as trucks, they have not at the same time been such conspicuous failures as to discourage further attempts in the same direction. The standing objections that such cars are too heavy, too noisy, too expensive, and not easily repaired, are offset not only by positive denials, but by the additional claim of greater safety, less liability to be splintered and broken up in collisions, and that when worn out, the material has a considerable market value, while wood is worthless.

It is safe to say that the model iron car has not yet been built, if indeed it has even an ideal existence in the mind of the inventor. But that it *will* be built seems to be a certainty, and we believe it will be within a very short time. When we consider the innumerable uses to which this metal is applied, and the extent to which it has taken the place of wood in our street architecture and in the building of ships and bridges, there would seem to be no sufficient reason why it should not be still further utilized in the matter of cars. This does not imply that it is equally suited for all structures heretofore made of wood. It would not make good boat oars, or packing boxes, or axe handles. The people of the middle ages little dreamed that ships could be made of iron, without going down as soon as launched. Railway cars are not ships, to be sure, but they are subject to certain peculiar conditions inseparable from the uses they perform, which are rapid locomotion, a minimum of weight, constant liability to violent concussion, and a capability of being easily repaired. These do not preclude the use of iron as a material of construction, nor does it follow that such material can not be adapted to meet all these conditions. The supply of timber is limited,

while iron is inexhaustible, and with increased means of production, is likely to become cheaper instead of dearer, even in the face of increased consumption.

There are obstacles to the ready introduction of metallic cars on our roads, aside from their alleged defects, and which can only be gradually overcome. These are a natural dislike of any innovation which is likely to complicate business in the shops, or render necessary the organization of new departments and the employment of a distinct class of mechanics from those now employed.—*The National Car-Builder.*

THE HEIGHT OF CUTTING TOOLS.

To the Editor of the Scientific American:

If T. J. B. is willing to learn any thing, I propose to give him an opportunity to do so. He says that a tool hardened according to my instructions will crumble, and can not be used. I say that on the other hand it will give the utmost attainable amount of duty. Thus, then, on this point we come down to a simple question of fact, and since the proof is at hand it may as well be quoted.

Laffan & Co. say in reply to my inquiries as to a tool similar in outline to No. 7, to which T. J. B. takes such especial objection:

"With the tool you lent us we have turned 16 feet of wrought-iron shafting, 2¼ inches in diameter, in three quarters of an hour. We use those tools altogether, and find they will take a cut 16 feet long, on shafts of the above size, without taking the tool out. In our lathe, which is an ordinary one, we use one tool fastened in the tool post in the usual way. As to the hardening question, we make our tools as hard as fire and water will make them, and sometimes make them still harder by adding salt to the water. We never temper a tool at all unless because it is a slight one, and thus our practice agrees with the directions given in your book, *The Complete Practical Machinist.*"

The large planer at the Morgan Iron Works will take in a piece of work 14 feet 6 inches wide, 12 feet high, and will plane 27 feet long at one cut.

Mr. Henry McCullough, the well-known foreman of those works, says: "We make our tools for this machine as hard as fire and water will make them. Especially is this necessary for hard iron, and even under these circumstances the tools never crumble. We keep the height of the cutting edge of the tool about the height of the top of the tool steel."

Wm. K. Byrnes says: "I make my tools as hard as the water will make them, or give them all the water, as we call it, and never temper a tool unless it is one comparatively weak, to suit some special job. The form of tool shown in Fig. 7 is the one I use, making its keenness to suit the size of the work. For hard cast iron I put salt in the water, heat the tool to a cherry red, and quench it right out in the water, and find I can get most work out of it that way. If I temper the tool I can not get so much work out of it." Speaking of the importance of keeping the cutting point well back, instead of in advance of the tool, he says: "By adopting that plan, I bored out a cylinder about 60 inches diameter, and 6 feet long, using a boring bar only 9 inches in diameter, making a smooth job of it, in spite of the comparative smallness of the boring bar, and although the thickness of the cylinder was only ⅜ inch."

Mr. George Seddon, the well-known expert lathe hand, of the Freeland Tool Works, says: "For general purposes I give my turning tools all the water, and do not temper them at all. I use the tool shown in Fig. 7, but do not take them down quite so much in the neck. When the tool is a comparatively *weak one*, I temper it. It is ridiculous to talk of lowering screw-cutting tools to a blue."

This is for the present sufficient; and now for T. J. B.'s lesson. It will hardly be denied that it is desirable to have tools as hard as they will stand, and since hard metals even can be cut with tools given all the water, where is the need of tempering them? That many do temper them, I am well aware; but that it is, unless for a comparatively weak tool, unnecessary, the experience of all the quickest workmen I know is proof. T. J. B. may find plenty of men to vouch that they lower the temper of the tools, but this simply shows that turning can be done with tools partly softened; a fact which every body knows. But since the harder the cutting tool the greater its cutting durability so long as the tool will stand it (and since the above evidence tallies with my twenty odd years of experience that ordinary tool steel will stand it), there is left nothing to say, unless it be as to the amount of the duty.

On this point I will say that George Seddon turned, in my presence, cast-iron pulleys 16 inches diameter, and 6 inch face, using a cutting speed of 38 feet per minute, and a feed of about 16 lathe revolutions to an inch of tool travel. The speed at which Laffan & Co. turned, with the tool I lent them, and at which they usually turn, 16 feet lengths of 2¼ shafting, is 44 feet per minute. That is to say, the shaft 2¼ inches diameter makes 68$\frac{4}{10}$ revolutions per minute, the tool travelling $\frac{1}{16}$ inch per revolution. Now let T. J. B. do this much work with a tempered tool.

I have obtained engravings of Sir Joseph Whitworth's lathes and planers, with the tools in position, and I hold them ready to publish if necessary. I find the tool edge in no case stands above the level of the face of the tool steel, and in order to do this without weakening the tool he bends the tool back, as shown in Fig. 17, in *The Complete Practical Machinist*. I am informed by those who have full engravings of his machines, and lathe and planer tools, that such is Whitworth's invariable practice. I had found the benefits of this plan from practice, but when I advocated and published the idea in the Scientific American, and in *Engineering*, about two years ago, I thought the idea original with myself. Only yesterday, however, I heard of a very expert workman at Messrs. Sargent & Cullingworth's establishment in this city, who says, "The tool must be bent back if you want fine work;" and this is undoubtedly true. I do not advocate Whitworth's plan of bending tools back for all turning and planing purposes, because I am doubtful as to whether the extra trouble does not more than balance the advantage gained; and therefore it is that I have as a rule omitted the bending, and at the same time cautioned our workmen against the evil it is intended to avoid. This was my especial object in the article that T. J. B. so much needed and is so little willing to accept. He goes in on general principles, "I object to every thing;" but before noticing his objections, let me show that I have not omitted directions for tool tempering for those cases in which it is necessary. On 205 and the following pages of *The Complete Practical Machinist* will be found as follows: "The degree to which a tool may be hardened is dependent in a great measure upon its shape. The only reason for tempering any lathe tool is to strengthen it, for steel hardened right out is comparatively weak, and gains strength by being tempered. The lower the temper the greater the strength. A straw color is well adapted to ordinary light tools, but very slight tools, such as say a parting tool $\frac{1}{16}$ inch wide, may be lowered to a deep brown or almost a purple. The practice of lowering stout tools to a straw color is sometimes resorted to, but it is certainly an error, for it is undoubtedly advantageous to make the tool as hard as it can be made, so long as it will bear the strain of the cut, which is possible and easy of accomplishment with Jessop's, Moss's, Sanderson's or other similar grades of tool steel. If a tool so hardened is found to break, it is in consequence either of its being bad steel, or else it has been heated to too great a temperature in the process of forging or hardening, unless it has been given too much rake for the duty to which it has been allotted. Tool steel may be forged at such a temperature that it is *not positively burned, and yet has lost part of its virtue*; and while under such circumstances it would break if hardened right out, it will cut and stand moderately well if the temper be lowered to a straw color."

Now if T. J. B. takes notice he will find his results exactly here described, but whether from the causes stated I could not say without trying one of the tools. T. J. B. can, however, satisfy himself, for the feed and speed together with the length of the cut will tell the story. I have omitted the depths of the cut, and so will here say that I can take a lathe of 6-inch centres and 1½-inch belt, and with a tool hardened right out cut a piece of cast steel of 2 inches diameter down to 1½ diameter, cutting it at a speed of 18 feet per minute, feed 20 revolutions to an inch of tool travel. Or I can turn a 6-inch shaft at a speed of 20 feet per minute, cut ⅜ inch deep, feed same as above.

It is entirely unnecessary to follow T. J. B. in his rambling objections more than to say that in the article to which he objects, the sole subject-matter, so far as the tools illustrated were concerned, was the height of the cutting point of the tool from the face upon which it rested; and since it was said, "Now it is obvious that the height of the cutting edge of the tool from the bottom of the tool is regulated to a great extent by the distance between the top face A of the slide-rest and the horizontal centre of the lathe centre," it is self-evident that the excessively turned-up tools could apply only to planer tools. And as no mention was made of the Niles' or any other manufacturer's tools, the affidavit he is prepared to make has no standing in the case. It is my aim to instruct, not to advertise any body either to their advantage or disadvantage. Otherwise I should produce affidavits describing tools exhibited that are forged with the cutting edge over two inches from the bottom of the steel, and probably nearer three inches. It happens that others than myself examined in my presence just such a tool.

My position upon the manual dexterity part of the question is simply that the hands obey the brain, and whatever the hands can do the brain ought to be able to explain to others how to do. I believe American practice to be at least equal to any other that I have seen, and I know that in each there is room for improvement. The way to improve lies in imparting our knowledge one to the other in a proper spirit, and, where ideas disagree, we must *compare results*, and if T. J. B. does this he will find his time will be more profitably employed in reading and with his tools than in attempting to instruct.

T. J. B. is very unfortunate, since it was the identical draughtsmen and engraver whom he mentions who found it impracticable to draw the tool—that is to say, the view of it that was required to show both the angles. One view of the tool in question will be found on page 19 of *The Complete Practical Machinist*, and an explanation of it was also published in vol. 30, page 389, of the Scientific American.

JOSHUA ROSE.

NEW METALLIC ALLOY.

By the combination of bronze with spiegeleisen or ferro-manganese, Mr. P. M. Parsons, of Blackheath, has succeeded in producing an alloy which is claimed to be more homogeneous and closer in texture, harder, and stronger than most of the alloys of which copper forms the base. In carrying out his invention he finds that to obtain the best effects it is desirable that the ferro-manganese to be used with gun-metal alloys (he designates as gun metal alloys those composed of copper and tin; as bronze, those composed of copper, and tin, and zinc) should be richer in manganese than that used with the brass alloys, while that used with the bronze alloys may be between the two, and regulated as conveniently as can be by the proportions of tin and zinc employed—that is to say, if little zinc is used in the bronze alloy the ferro-manganese employed may be as rich, or nearly as rich, in manganese as in the gun-metal alloys, while if the zinc predominates the ferro-manganese employed may be the same as or a trifle richer in manganese than that used with the brass alloys; and if the zinc and the tin are about equal, the quantity of the manganese contained in the ferro-manganese may be between that used for the gun-metal and that used for brass alloys. The ferro-manganese used to mix with the gun-metal alloys should contain from about 10 to 40 per cent of metallic manganese, while that used to mix with the brass alloys should contain from about 5 to 20 per cent of metallic manganese, and that used for the bronze alloys should be between the two, according to the proportions of tin and zinc employed.

In selecting the ferro-manganese it is very desirable that it should contain as little silicon as possible; when spiegeleisen can be contained of the best quality, containing but a minute quantity of silicon and from 5 to 10 per cent of manganese, it will be suitable to mix with the brass alloys, and it may even be used with the gun-metal alloys; but it will be found advantageous to employ for both as well as for the bronze alloys a ferro-manganese thus manufactured. He obtains ferro-manganese as now manufactured for and used in steelworks rich in metallic manganese, containing (say) from 50 to 60 or even 70 per cent; this he melts in a crucible under powdered charcoal along with the requisite proportion of the purest wrought-iron scrap he can obtain to bring down the quantity of metallic manganese to any of the proportions before named: he thus obtains a ferro-manganese containing the least possible quantity of silicon. Thus, supposing it is desired to employ a ferro-manganese to mix with any of the before-named alloys containing 20 per cent of manganese, and a ferro-manganese containing 60 per cent of metallic manganese and (say) 1 per cent of silicon is melted with wrought-iron scrap in the proportion of 100 of ferro-manganese to 200 of wrought-iron scrap, a ferro-manganese containing the desired quantity of metallic manganese—20 per cent—will be obtained containing only one third per cent of silicon instead of 1 per cent, and so on for any other proportions required; not only this, but a still further portion of the silicon is eliminated, and the metal refined by this second melting in a crucible.

The quantity of ferro-manganese to be employed will vary both with the nature of the alloy as well as with the quality required in each particular alloy, and this will also to a certain extent have to be regulated by the quality of the copper, tin, and zinc employed; the purer these metals, the larger may be the quantity of ferro-manganese employed, and, therefore, no precise quantities can be specified; but generally for ordinary gun-metal—that is to say, gun-metal composed of about 90 per cent of copper and 10 per cent of tin—from ½ to 1½ per cent of ferro-manganese, as above described, may be added, containing (say) about 20 per cent of metallic manganese, and as the tin is increased the ferro-manganese should contain more manganese and less iron. The quantity of ferro-manganese employed should be regulated according to the purposes for which the alloy is intended to be used; generally the effect produced is with the smaller quantities named to increase the strength of the alloy and the hardness slightly, and as the quantity of ferro-manganese is increased the hardness is also increased, but at the same time the alloy becomes more brittle. A similar effect is produced by the addition of the ferro-manganese to the brass and bronze alloys. With the brass alloys from ½ to 5 per cent of the ferro manganese, as above described, may be employed with advantage for general purposes, and for the bronze alloys any proportions between those to be used for the gun-metal and brass alloys may be advantageously used, these proportions being adjusted according to the quantities of tin and zinc used—that is to say, the more tin used the less should be the quantity of ferro-manganese.

In carrying out the invention, the copper should be first melted in a crucible or other vessel in the ordinary manner, and the spiegeleisen or ferro-manganese, either with or without the addition of wrought-iron scrap as before described, should at the same time be melted in a separate smaller furnace capable of generating a high temperature in a plumbago crucible under powdered charcoal, and when it is completely fused, and the copper is also fused, and at a boiling heat, the ferro-manganese should be poured into the copper and the two well mixed together by stirring with an iron rod previously made red-hot; the tin, or zinc, or both, should then be added in the usual way and in the requisite proportions, according to the kind of alloy it is desired to produce. After the tin and zinc are added the metal should be again well stirred with a red-hot rod and skimmed; it may then be either poured into ingot moulds for future use or it can at once be cast in moulds to produce any articles required. In making castings he finds that dry sand or loam moulds well coated with charcoal blacking are preferable to green-sand moulds; the metal should be well skimmed before pouring, and it should be cast at as low a heat as possible, so long as it is sufficiently fluid to fill the mould, and the runner should have a good head and be attached to the thickest part of the casting, which, if possible, it should exceed in bulk, so as to solidify the last and act as a feeder while the cast is cooling. If metal moulds are employed the alloy is rendered closer in texture and somewhat harder.

SAFETY LAMP CLEANER.

A machine, which is claimed to offer great advantages in the cleaning of the gauzes and metal of miners' safety lamps, has been introduced in England. It is very simple, consisting of two spindles running parallel with each other, to which the brushes are fixed by screw nuts; they are driven by a foot treadle and grooved with gut bands. The gauze to be cleaned is placed upon the top brush, which will just fill the inside; held loosely in the left hand two or three turns of the grooved wheel will be found sufficient to clean the gauze. The right hand is at liberty to sprinkle the flint dust upon the gauze. The smaller brush revolving inside and the larger one outside in the same direction, the dirt and dust are rapidly cleaned off. It is only necessary to change the gauze-cleaning brushes for a fibre brush supplied with the machine, to polish the metal of the lamp, by holding the part to be operated upon close to the revolving brush, charged with a little rottenstone and oil.

ROMAN MAGNIFICENCE.

If any thing were wanted to give us an idea of Roman magnificence, we would turn our eyes from public monuments, demoralized games and grand processions, we would forget the statues in brass and marble, which outnumbered the living inhabitants, so numerous that one hundred thousand have been recovered and still embellish Italy; and would descend into the lower sphere of material life—those things which attest luxury and taste—to ornaments, dresses, sumptuous living, and rich furniture.

The art of using metals and cutting precious stones surpassed any thing known at the present day.

In the decoration of houses, in social entertainments, in cookery, the Romans were remarkable. The mosaic, signet rings, cameos, bracelets, bronzes, vases, couches, banqueting tables, lamps, chariots, colored glass, gilding, mirrors, mattresses, cosmetics, perfumes, hair dyes, silk ribbons, potteries, all attest great elegance and beauty. The tables of thuga root and Delian bronze were as expensive as the sideboards of Spanish walnut, so much admired in the Great Exhibition at London.

Wood and ivory were carved as exquisitely as in Japan or China.

Mirrors were made of polished silver. Glass cutters could imitate the colors of precious stones so well, that the Portland vase, taken from the tomb of Alexander Severus, was long considered as a genuine sardonyx. Brass could be hardened so as to cut stone.

The palace of Nero glittered with gold and jewels. Perfumes and flowers were showered from ivory ceilings. The halls of Heliogabalus were hung with cloth and gold, enriched with jewels. His beds were silver, and his tables of gold. Tiberius gave a million of sesterces for a picture for his bedroom. A banquet dish of Dæsillus weighed five hundred pounds silver.

The cups of Drusus were of gold. Tunics were embroidered with the figures of various animals. Sandals were garnished with precious stones. Drinking cups were engraved with scenes from the poets. Libraries were adorned with busts and with tortoise shell, and covered with gorgeous purple.

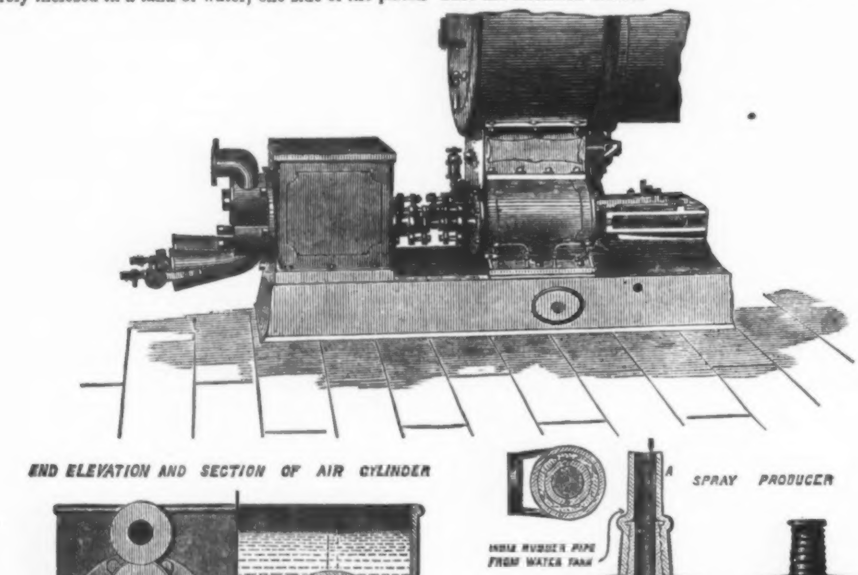
The Roman grandees rode in gilded chariots, bathed in marble baths, dined on golden plate, drank from crystal cups, slept on beds of down, reclined on luxurious couches, wore embroidered robes, and were adorned with precious stones.

They ransacked the earth and the seas for rare dishes for their banquets, and ornamented their houses with carpets from Babylon, onyx cups from Bithynia, marbles from Numidia, bronzes from Corinth, statues from Athens—whatever, in short, was precious or curious in the most distant countries.

The luxuries of the bath almost exceed belief, and on the walls were magnificent frescos and paintings, exhibiting an inexhaustive productiveness in landscape and mythological scenes.

NEW AIR COMPRESSOR.

WE illustrate below an arrangement of machinery for compressing air, by Messrs. Robey & Co., Perseverance Works, Lincoln, England. The air cylinders are single-acting, and are entirely inclosed in a tank of water, one side of the piston



THE ROBEY AIR COMPRESSOR.

and the entire inner surface as well as the outer surface of the air cylinder being thus exposed to water at every stroke. While this helps to keep the cylinders cool in an effectual manner, it yet acts but very partially on the contained air, which is a bad conductor of heat.

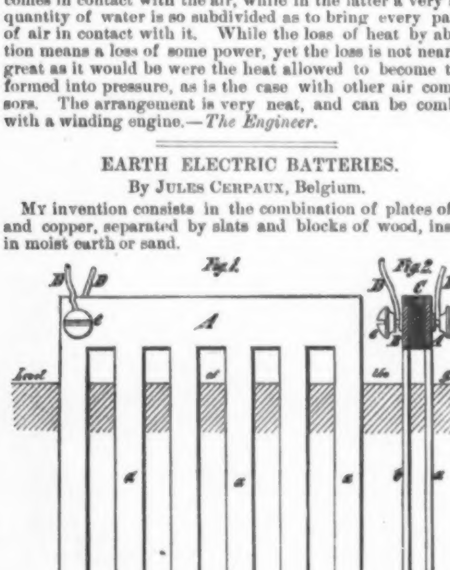
For the purpose of keeping down the temperature of the air, Messrs. Robey use the apparatus shown in section. This is simply a large spray; the pipe A is attached to the water cistern by a flexible tube, and the pipe B to the air receiver. This being fixed as shown in the centre of the bell mouth, through which the air is drawn, injects at each stroke a very small quantity of water in the form of a cloud, thus bringing each particle of air in absolute contact with an infinitely small particle of water; and as water has so much greater capacity for heat than air, the whole of the heat generated is absorbed, and the air is scarcely raised in temperature.

It will be seen that there is a great difference between injecting water in the form of a jet as is done by some makers, and in the form of a cloud as by this apparatus. In the former case but a small surface of a large quantity of water comes in contact with the air, while in the latter a very small quantity of water is so subdivided as to bring every particle of air in contact with it. While the loss of heat by absorption means a loss of some power, yet the loss is not nearly so great as it would be were the heat allowed to become transformed into pressure, as is the case with other air compressors. The arrangement is very neat, and can be combined with a winding engine.—*The Engineer.*

EARTH ELECTRIC BATTERIES.

By JULES CERPAUX, Belgium.

MY invention consists in the combination of plates of zinc and copper, separated by slats and blocks of wood, inserted in moist earth or sand.



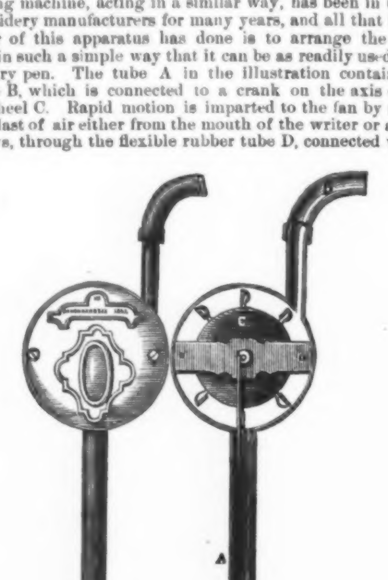
ELECTRIC EARTH BATTERY.

In Figs. 1, 2, and 3, A and B are plates of copper and zinc, consisting of flat strips with teeth or blades. The plates are separated from each other by strips of wood C, or other insulating material, and their teeth or blades *a b* are separated by blocks *c* of the same material. Wires D, or other electrical conductors, are fastened by screw-cups *e*, or other means, to the plates A B, and may be connected at pleasure to produce the electrical circuit.

These electric piles are inserted in moist earth or sand, or in a gaseous place, and the consequent action upon the metals produces an electric current.

PNEUMATIC PEN.

AMONG the many attempts of inventors to supply a ready means of copying an indefinite number of writings, drawings, etc., is the apparatus shown in sketch, which, apart from the question of utility, is at least simple and ingenious. The pneumatic pen, as it is called, is not new in principle, as a perforating machine, acting in a similar way, has been in use by embroidery manufacturers for many years, and all that the inventor of this apparatus has done is to arrange the whole thing in such a simple way that it can be as readily used as an ordinary pen. The tube A in the illustration contains the needle B, which is connected to a crank on the axis of the fan-wheel C. Rapid motion is imparted to the fan by means of a blast of air either from the mouth of the writer or an air-bellows, through the flexible rubber tube D, connected with a



PNEUMATIC PEN.

foot-bellows or blown from the mouth of the operator. On moving the point of the pen over a sheet of paper, it becomes pierced with very fine holes in lines of the desired pattern. Ink or color is then spread over the surface which fills the holes, and passes through the stencil to as many sheets of paper as may be brought in contact with it. Originals may, it is stated, be multiplied in this way at the rate of 300 per hour. —*Eng. Mechanic.*

THE MANUFACTURE OF ARTIFICIAL BUTTER.

By HENRY A. MOTT, JR., E.M., Ph.D.

(With Six Illustrations.)

(*Continued from page* 761.)

THE plan of a factory given herewith, Fig. 1, is intelligible from the engraving. The space is very conveniently divided as actual experiment has demonstrated. This general arrangement is recommended for establishments where the process of heating fat and oil is to be carried on on one floor, as considered in the estimates hereinafter given.

"Fig. 2 represents the 'Hashing Machine,' which consists of a series of sharp blades set on an axis like the thread of a screw. These are contained in a closely-fitting chamber or cylinder placed horizontally. The cylinder is divided into two portions, hinged together on one side, and capable of being securely fastened or bolted on the other, when the machine is in operation. The upper half can be readily thrown back should the machine become clogged or when it becomes necessary to clean it. The shaft on which the knives are fixed extends through one end of the cylinder, and is geared in the ordinary way, by means of a belt and pulley, to the shaft of the engine transmitting the power." "A huge iron trough of porcelain is supported above the cylinder. This trough or feeder has an aperture in one corner, which fits over a corresponding hole in the upper part of the cylinder, through which the suet is fed to the machine. At the opposite end of the cylinder to which the fat is admitted, is placed a perforated iron plate, through which the suet is pressed out."

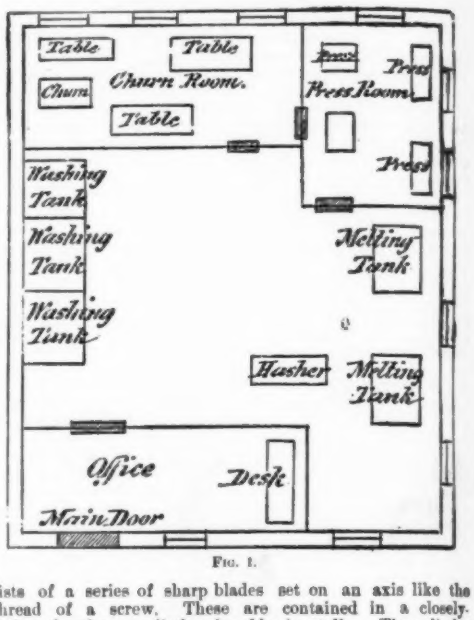


FIG. 1.

The "Melting Tank" is shown in Fig. 3. It consists of a large cylindrical galvanized iron vessel, about 3 feet in diameter and 2½ feet in depth, provided with a jacket or outer wall, which may be of wood, having a space between the two of about 2½ inches, which space is filled partly up with water, and the water is heated by the introduction of steam through a pipe descending through the same.

The "car" is represented in the figure, which should, for convenience, be square, about 3 feet by 3 feet by 15 inches.

Fig. 4 represents a table on which are small wooden or tin moulds, six or eight inches long, four or six inches wide, and

FIG. 2

two inches deep, each one containing a piece of cloth large enough to make up into a package. The cloth should have margin enough to form a double lap from each side. The bags when filled contain about two pounds each.

Fig. 5 represents the most convenient and suitable press. The "bags" will be noticed in the press between the plates. A tin trough on which the bottom plate rests will also be noticed. This trough should be about two inches in height, having a lip in front for the oil to flow over. The press should be inclined slightly forward so as to allow the oil to flow over the lip more rapidly.

The churns used in the different factories which were under my direction were the "Union Churns" represented in Fig. 6. These always proved in every way suitable.

COMPOSITION OF ARTIFICIAL BUTTER.

I have subjected a number of samples of artificial butter to analysis, and find :

ANALYSIS OF ARTIFICIAL BUTTER.

Constituents.	Good Sample.	Good Sample.	Sample not so good.
Water	12.13	11.88	19.68
Butter—solids	87.87	88.12	80.32
	100.00	100.00	100.00
Fats {Olein, Palmitin, Stearin, Butyrin, etc.}	82.41	81.64	75.39
Casein	.63	.86	.91
Salt	4.83	5.62	4.02
Coloring matter	Trace.	Trace.	Trace.
	87.87	88.12	80.32

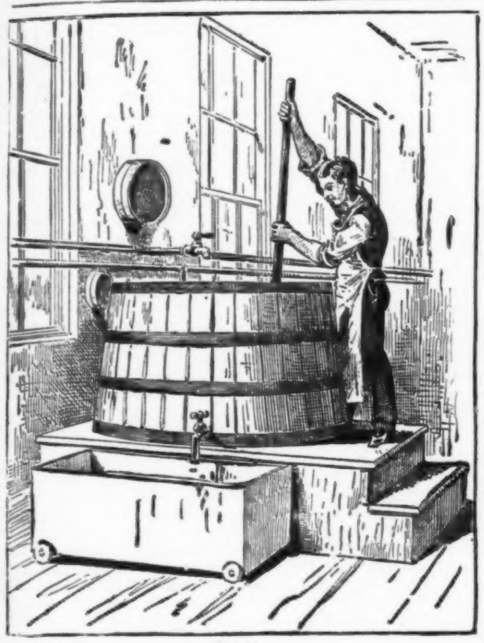


FIG. 3.

I find an analysis of artificial butter by Dr. Brown, which I compare in the following table with an average of my first two analyses given below, as also with an analysis of butter made from cream.

BUTTER ANALYSES.

Constituents.	Artificial Butter. By Dr. Brown. I.	Artificial Butter. Average of two Analyses. By Mott. II.	Butter made from cream. By Mott. III.	Same as III. Calculated to 5.225% of salt.
Water	11.25	12.005	12.29	11.827
Butter—solids	88.75	87.995	87.71	88.173
	100.00	100.000	100.00	100.000
Fats {Olein, Palmitin, Stearin, Butyrin, etc.}	87.15	82.025	86.01	87.765
Casein	.57	.745	.19	.183
Salt	1.03	5.225	1.51	5.225
Coloring matter	Trace.	Trace.	....	....
	88.75	87.995	87.71	88.173

FIG. 4.

It will be seen, by comparing the three first analyses in the above table, that the difference in the percentage of fat in my analyses and either of the others is owing to greater percentage of salt (this is easily seen by comparing No. III. with the last analysis), which element may be reduced or augmented in the manufacture to suit the taste and requirements. The amount of casein is also a trifle higher in the artificial than in the natural product, but not sufficient to make any difference.

I have carefully calculated the proportion of the different fats with respect to their melting points :*

* The specific heats were not considered.

ANALYSES OF THE FATS OF BUTTER.

(Partly calculated.)

Constituents.	Fats from Natural Butter.	Fats from Artificial Butter.
Palmitin ($C_{51}H_{98}O_6$)	20.33	22.32
Stearin ($C_{57}H_{110}O_6$)	42.77	46.94
Olein ($C_{57}H_{104}O_6$)	27.71	30.42
Butyrin ($C_{15}H_{26}O_6$), Caproin ($C_{21}H_{38}O_6$), Caprin ($C_{33}H_{62}O_6$), Caprylin ($C_{27}H_{50}O_6$)	9.19*	.32
	100.00	100.00

By comparing the constituents of these two analyses, it will at once be seen that the difference in the per cent of the different constituents arises from the very small amount of butyrin, etc., in the artificial product, and it is for this reason that the artificial butter keeps so much better than natural butter. There is sufficient of the butyrin in the butter to give it the odor, flavor, and taste of butter, but not sufficient when decomposed into butyric acid to give the product an odor.

I have calculated the amount of the individual constituents in the fat in my analysis of natural butter and my average analysis of artificial butter, and substituted the same with the following results :

COMPLETE ANALYSIS OF BUTTER.

(Partly calculated.)

Constituents.	Natural Butter.	Artificial Butter (when properly made).
Water	11.827	12.005
Butter—solids	88.173	87.995
	100.000	100.000
Palmitin ($C_{51}H_{98}O_6$)	16.827	18.307
Stearin ($C_{57}H_{110}O_6$)	35.909	38.502
Olein ($C_{57}H_{104}O_6$)	22.934	24.954
Butyrin ($C_{15}H_{26}O_6$), Caproin ($C_{21}H_{38}O_6$), Caprin ($C_{33}H_{62}O_6$), Caprylin ($C_{27}H_{50}O_6$)	7.505	.262
Casein	.183	.745
Sodic Chloride (Salt)	5.225	5.225
Coloring matter	....	Trace.
	88.173	87.995

DETAILS OF AND COST OF MANUFACTURE.

A large floor should be selected in some building easy of access, having steam-power and plenty of running water. A floor fifty by seventy-five feet, properly divided,† is large enough conveniently to manufacture 500 lbs. of butter per day. The rent of such floor should be about $500 a year.

The cost of fitting up a factory will amount to about $2500. For manufacturing 500 lbs. of butter per day, there will be needed : 1 hasher, 2 melting-tanks, 1 churn, 2 presses, 3 wash-tanks ; besides washtubs, tin cans, cloths, etc.

After paying for the fitting up of the factory, there should be at least $3000 in bank for several reasons. First, three days will elapse before any butter is ready for sale, and six weeks will elapse before the first butter sold is paid for. Butter is sold on six weeks, while caul fat is sold for cash.

The amount of fat needed there to carry on the business for 39 working days will be (490.19 lbs. per day, at 10 cts., $49.01), 19,117.41 lbs., which will cost, at 10 cents per pound, $1911.74. The tubs for the butter will amount to 10 a day, at 15 cents, $1.50 ; 39 days, $58.50.

The men and boys must be paid every week. There will be required 1 superintendent, at $50; 1 butter-worker, at $40 ; 2 boys, at $6 ; 1 woman, at $5. For six weeks, at $107 = $642.

Stated together :

Fat, 18,525 lbs. for six weeks, etc., at 10 cts.	$1911 74
Tubs, 390, at 15 cents	58 50
Labor	642 00
Contingencies (milk, ice, annatto, etc.)	387 76
	$3000 00

By combining the cost of fitting up the factory with the amount of money paid out before any returns are made ($2500 + $3000 = $5500), it will be seen that it would not be safe to enter in the business without $5500. To ascertain the cost of manufacture, several points must be ascertained.

First. The expense per day.

Second. The exact amount of butter manufactured

Third. The amount of stearine, etc., sold.

The following table will give the percentage of fat, oil, and butter realized, which is necessary for the calculation of costs, etc. :

PERCENTAGE OF REFINED FAT, OIL, SCRAP, GREASE, STEARINE, AND BUTTER.

MELTING PROCESS.

Refined fat	78.63 per cent.
Soap grease	4.31 " "
Scrap (membrane)	17.06 " "
Total	100.00 " "

PRESSING PROCESS.

100 parts of refined fat.

Oil	76.31 per cent.
Stearine	23.69 " "
Total	100.00 " "

PER CENT OF OIL FROM 100 PARTS CAUL FAT.

Oil	60.00 per cent.
Stearine	18.63 " "
Scrap and soap grease	21.37 " "
Total	100.00 " "

CHURNING PROCESS.

100 parts of butter.

Oil	83.00 per cent.
Salt, milk, etc.	5.00 " "
Water	12.00 " "
Total	100.00 " "

* The butyric acid was ascertained by analysis, which is approximately correct. All volatile fats stated are calculated as butyrin.

† See plan of factory.

EXPENSES PER DAY AT FACTORY.

Fat	490.19 lbs., at 10 cts.	$49 00
Milk	84 qts., at 7 cts.	5 88
Bicarbonate of soda	1 lb., at 10 cts.	10
Salt	26 lbs., at 3 cts.	78
Ice	60 lbs., at ½ ct.	30
Labor*	(6 working days)	17 83
Rent, etc.	at $500 (259 working days)	2 00
Contingencies		20
Total expense per day		$76 00

PRODUCTS MANUFACTURED.

Butter made from 490.19 lbs. caul fat	500 lbs., at 25 cts.	$125 00
Stearine obtained " " "	91.32 lbs., at 11 cts.	10 04
Soap grease " " "	21.12 lbs., at 5 cts.	1 05
Scrap " " "	83.33 lbs.	Loss
Total		$136 09

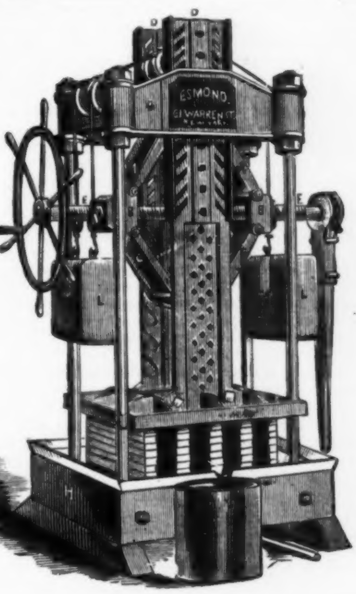


FIG. 5.

MONEY REALIZED BY BUSINESS PER DAY.

Received for butter, stearine, and soap grease	$136 09
Cost of manufacture	76 00
Amount realized above expenses	$60 09

COST OF MANUFACTURE PER POUND OF BUTTER.

The cost of manufacture will equal the expenses per day minus the amount of money realized from other products, such as stearine and grease.

Expenses per day	$76 00
Received of stearine and grease	11 00
Cost of manufacture	$64 91

Butter made from 490.19 lbs. of caul fat, 500 lbs. : Cost to manufacture per pound = 64.91 ÷ 500 = 12.98 cts., or 13 cts.

It may be well to state here, that, as the pure, inodorless sweet-oil can be obtained from the Commercial Manufacturing Co., which company only manufactures the oil, a capital of $5500 would not be necessary to enter into the business. If the oil was bought from the said company, a capital of about

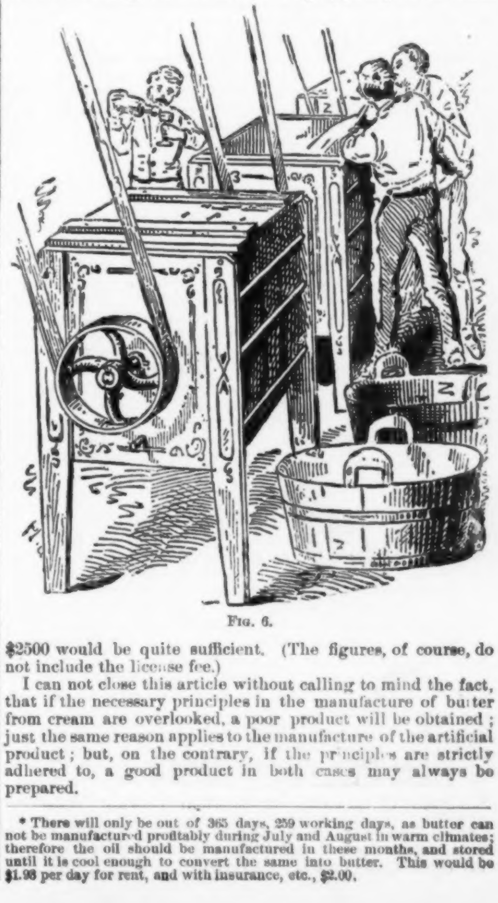


FIG. 6.

$2500 would be quite sufficient. (The figures, of course, do not include the license fee.)

I can not close this article without calling to mind the fact, that if the necessary principles in the manufacture of butter from cream are overlooked, a poor product will be obtained ; just the same reason applies to the manufacture of the artificial product ; but, on the contrary, if the principles are strictly adhered to, a good product in both cases may always be prepared.

* There will only be out of 365 days, 259 working days, as butter can not be manufactured profitably during July and August in warm climates; therefore the oil should be manufactured in these months, and stored until it is cool enough to convert the same into butter. This would be $1.93 per day for rent, and with insurance, etc., $2.00.

INTRODUCING QUEENS.

FOR the benefit of many inquirers we give the following. We think it the best plan to purchase and introduce your Italian queens in the fall—

1st. Because they are very much cheaper; and,

2d. You will then have them for early breeding, and it often happens in the spring that it is next to impossible to procure queens before the middle of June.

Prof. Cook, in his *Manual of the Apiary*, says: "First, we should seek out the old queen and destroy her, then cage our Italian queen in a wire cage, which may be made by winding a strip of wire cloth, three and one half inches wide, and containing from fifteen to twenty meshes to the inch, about the finger. Let it lap each way one half inch, then cut it off. Ravel out the half inch on each side, and weave in the ends of the wires, forming a tube the size of the finger. We now have only to put the queen in the tube, and pinch the ends together, and the queen is caged. The cage may now be inserted between two adjacent combs containing honey, each of which will touch it. The queen can thus sip honey as she needs it. If we fear the queen may not be able to sip the honey through the meshes of the wire, we may dip a piece of clean sponge in honey and insert it in the upper end of the cage before we compress the end. This will furnish the queen with the needed food. In 48 hours we again open the hive, after a thorough smoking, also the cage, which is easily done by pressing the upper end, at right angles to the direction of the pressure when we closed it. In doing this do not remove the cage. Now keep watch, and if as the bees enter the cage, or as the queen emerges, the bees attack her, secure her immediately and recage her for another 48 hours. I usually let some honey drip on the queen as soon as the cage is opened. Some think this renders the bees more amiable. I have introduced many queens in this manner, and never lost one, and never had to recage but one.

"If we are to introduce an imported queen, or one of very great value, we might make a new colony, all of young bees. Smoke them well, sprinkle with sweetened water, daub the queen with honey, and introduce immediately. This method would involve really no risk.

"By having a colony thus Italianized in the fall, we may commence the next spring, and ere another autumn have only the beautiful, pure, amiable, and active Italians. I have done this several times, and with the most perfect satisfaction. I think by making this change in blood we add $5 to the value of each colony, and I know of no other way to make money so easy and pleasantly."—*The Bee-Keepers' Magazine.*

GERMINATION OF SEEDS IN ICE.

WE have already referred to the fact, recently discovered, that several kinds of seeds will germinate between pieces of ice. A full investigation of the lower limit of temperature at which plants may germinate has recently been made by M. Haberlandt. The experiments were upon wheat, rye, barley, red beet, rape, lucerne, poppy, and many other seeds. Several hundred seeds were employed of each species, and every fourteen days the seeds were taken out of the ice-chest, whose temperature was kept constant between 0° and 1° C., and examined in a space whose temperature was under freezing-point. In forty-five days a decided beginning of germination was observable in eight different species (which are named). In four months it had continued to progress in a minority of these; the rest had stopped. In fourteen species there was no germination. M. Haberlandt is of opinion that those seeds which can germinate at a lower temperature than others of the same species will give plants that require a less amount of heat for their complete development than the others, and thus by artificial sowing in cold spaces a means is at hand of obtaining species soon ripe and needing little heat. Of all the seeds which had remained for four months in the ice-chest, only a few were found capable of development when brought into a warmer temperature of 16° C. These results are certainly very curious.—*Boston Journal of Chemistry.*

WHAT MAY BE MADE OF OUR WILD FRUITS.

PROFESSOR ASA GRAY believes that many native wild fruits in America may be developed to advantage. He says, "The leading instances, in my mind, are the persimmon and papaw; not the true papaw, of course, which we have in Florida, but the Asia Minor or Western papaw, so called. Both persimmons and papaws are freely offering, from spontaneous seedlings, incipient choicer varieties to be selected from both fruits when only a few years old, thereby accelerating the fixation of selected varieties into races; and both give fruits of types wholly distinct from any others we possess of temperate climates. Our American plums have for many years been in some sort of cultivation and have improved greatly upon the wild forms, but I suppose they have not been systematically attended to. Their exterior liability to black knot and other attacks renders them for the present unsuccessful. Finally, if pomology includes nuts, there is a promising field uncultivated. Our wild chestnuts are sweeter than those of the Old World; it would be well to try whether races might not be developed with the nuts as large as marrons or Spanish chestnuts, and without diminution of flavor. If we were not so easily satisfied with a mere choice between spontaneous hickory nuts, we might have much better and thinner shelled ones. The pecan is waiting to have the bitter matter between the kernel bred out; the butternuts and black walnuts too have their excess of oil turned into a farinaceous and sugary matter, and their shells thinned and smoothed by continued good breeding, when they will much surpass the European walnut."

VANILLIN FROM PINE TREES.

M. BOUQUET DE LA GRYE, on presenting to the Agricultural Society of France two samples of vanillin derived from the sap of the pine, made the following remarks: One of the samples is vanillin in a pure state, whilst the other is prepared for the uses of the confectioner. Vanillin exists in the sap of the pine (*Pinus sylvestris*) and of the larch. The first attempts at its extraction were made by Hofmann, but on a small scale. The price of vanillin, though high, in consequence of the operations necessary for its extraction and purification, is still lower than that of natural vanilla. The difficulty lies in procuring the sap. For this purpose the trees are felled during the period when vegetation is most active—in May and June—and stripped of their bark. They are then immediately scraped. The product of this operation, collected in vessels of tinned iron, is immediately heated on the spot to prevent fermentation, filtered, concentrated, and allowed to cool and settle. A substance is thus obtained which resembles powdered sugar, and which is known as coniferin. This is a stable compound, and is sent in barrels to Paris, where the vanillin is extracted.

THE ANTIQUITY OF MAN.

IN his recent opening address before the Biological section, British Association, Mr. Alfred Russel Wallace said: It is a somewhat curious fact, that, while all modern writers admit the great antiquity of man, most of them maintain the very recent development of his intellect, and will hardly contemplate the possibility of men equal in mental capacity to ourselves having existed in prehistoric times. This question is generally assumed to be settled, by such relics as have been preserved of the manufactures of the older races showing a lower and lower state of the arts; by the successive disappearance in early times of iron, bronze, and pottery; and by the ruder forms of the older flint implements. The weakness of this argument has been well shown by Mr. Albert Mott in his very original, but little known, presidential address to the Literary and Philosophical Society of Liverpool in 1873. He maintains that "our most distant glimpses of the past are still of a world peopled as now with men both civilized and savage"—and, "that we have often entirely misread the past by supposing that the outward signs of civilization must always be the same, and must be such as are found among ourselves." In support of this view he adduces a variety of striking facts and ingenious arguments, a few of which I will briefly summarize.

EASTER ISLAND REMAINS.

On one of the most remote islands of the Pacific—Easter Island—2000 miles from South America, 2000 from the Marquesas, and more than 1000 from the Gambier Islands, are found hundreds of gigantic stone images, now mostly in ruins, often thirty or forty feet high, while some seem to have been much larger, the crowns on their heads cut out of a red stone being sometimes ten feet in diameter, while even the head and neck of one is said to have been twenty feet high.* These once stood erect on extensive stone platforms, yet the island has only an area of about thirty square miles, or considerably less than Jersey. Now as one of the smallest images eight feet high weighs four tons, the largest must weigh over a hundred tons, if not much more; and the existence of such vast works implies a large population, abundance of food, and an established government. Yet how could these co-exist in a mere speck of land wholly cut off from the rest of the world? Mr. Mott maintains that this necessarily implies the power of regular communication with larger islands or a continent, the arts of navigation, and a civilization much higher than now exists in any part of the Pacific. Very similar remains in other islands scattered widely over the Pacific add weight to this argument.

THE NORTH AMERICAN MOUNDS.

The next example is that of the ancient mounds and earthworks of the North American continent, the bearing of which is even more significant. Over the greater part of the extensive Mississippi valley four well-marked classes of these earthworks occur. Some are camps, or works of defence, situated on bluffs, promontories, or isolated hills; others are vast inclosures in the plains and lowlands, often of geometric forms, and having attached to them roadways or avenues often miles in length; a third are mounds corresponding to our tumuli, often seventy to ninety feet high, and some of them covering acres of ground; while a fourth group consist of representations of various animals modelled in relief on a gigantic scale, and occurring chiefly in an area somewhat to the north-west of the other classes, in the plains of Wisconsin.

The first class—the camps or fortified inclosures—resemble in general features the ancient camps of our own islands, but far surpass them in extent. Fort Hill, in Ohio, is surrounded by a wall and ditch a mile and a half in length, part of the way cut through solid rock. Artificial reservoirs for water were made within it, while at one extremity, on a more elevated point, a keep is constructed with its separate defences and water-reservoirs. Another, called Clark's Work, in the Scioto Valley, which seems to have been a fortified town, incloses an area of 127 acres, the embankments measuring three miles in length, and containing not less than three million cubic feet of earth. This area incloses numerous sacrificial mounds and symmetrical earthworks, in which many interesting relics and works of art have been found.

The second class—the sacred inclosures—may be compared for extent and arrangement with Avebury or Karnac—but are in some respects even more remarkable. One of these, at Newark, Ohio, covers an area of several miles with its connected groups of circles, octagons, squares, ellipses, and avenues, on a grand scale, and formed by embankments from twenty to thirty feet in height. Other similar works occur in different parts of Ohio, and by accurate survey it is found not only that the circles are true, though some of them are one third of a mile in diameter, but that other figures are truly square, each side being over 1000 feet long, and what is still more important, the dimensions of some of these geometrical figures in different parts of the country and seventy miles apart, are identical. Now this proves the use, by the builders of these works, of some standard measures of length, while the accuracy of the squares, circles, and, in a less degree, of the octagonal figures—shows a considerable knowledge of rudimentary geometry, and some means of measuring angles. The difficulty of drawing such figures on a large scale is much greater than any one would imagine who has not tried it, and the accuracy of these is far beyond what is necessary to satisfy the eye. We must therefore impute to these people the wish to make these figures as accurate as possible, and this wish is a greater proof of habitual skill and intellectual advancement than even the ability to draw such figures. If, then, we take into account this ability and this love of geometric truth, and further consider the dense population and civil organization implied by the construction of such extensive systematic works, we must allow that these people had reached the earlier stages of a civilization of which no traces existed among the savage tribes who alone occupied the country when first visited by Europeans.

SEPULCHRAL AND SACRIFICIAL MOUNDS.

The animal mounds are of comparatively less importance for our present purpose, as they imply a somewhat lower grade of advancement; but the sepulchral and sacrificial mounds exist in vast numbers, and their partial exploration has yielded a quantity of articles and works of art, which throw some further light on the peculiarities of this mysterious people. Most of these mounds contain a large concave hearth or basin of burnt clay, of perfectly symmetrical form, on which are found deposited more or less abundant relics, all bearing traces of the action of fire. We are, therefore, only acquainted with such articles as are practically fire-proof. These consist of bone and copper implements and ornaments, disks, and tubes—pearl, shell, and silver beads, more or less injured by the fire—ornaments cut in mica, ornamental pottery, and numbers of elaborate carvings in stone, mostly forming pipes for smoking. The metallic articles are all formed by hammering, but the execution is very good; plates of mica are found cut into scrolls and circles; the pottery, of which very few remains have been found, is far superior to that of any of the Indian tribes, since Dr. Wilson is of opinion that they must have been formed on a wheel, as they are often of uniform thickness throughout (sometimes not more than one sixth of an inch) polished, and ornamented with scrolls and figures of birds and flowers in delicate relief. But the most instructive objects are the sculptured stone pipes, representing not only various easily recognizable animals, but also human heads, so well executed that they appear to be portraits. Among the animals, not only are such native forms as the panther, bear, otter, wolf, beaver, raccoon, heron, crow, turtle, frog, rattlesnake, and many others, well represented, but also the manatee, which perhaps then ascended the Mississippi as it now does the Amazon, and the toucan, which could hardly have been obtained nearer than Mexico. The sculptured heads are especially remarkable, because they present to us the features of an intellectual and civilized people. The nose in some is perfectly straight, and neither prominent nor dilated, the mouth is small, and the lips thin, the chin and upper lip are short, contrasting with the ponderous jaw of the modern Indian, while the cheek-bones present no marked prominence. Other examples have the nose somewhat projecting at the apex in a manner quite unlike the features of any American indigenes, and, although there are some which show a much coarser face, it is very difficult to see in any of them that close resemblance to the Indian type which these sculptures have been said to exhibit. The few authentic crania from the mounds present corresponding features, being far more symmetrical and better developed in the frontal region than those of any American tribes, although somewhat resembling them in the occipital outline;* while one was described by its discoverer (Mr. W. Marshall Anderson) as "a beautiful skull, worthy of a Greek."

The antiquity of this remarkable race may perhaps not be very great, as compared with the prehistoric man of Europe, although the opinions of some writers on the subject seem affected by that "parsimony of time" on which the late Sir Charles Lyell so often dilated. The mounds are all overgrown with dense forest, and one of the large trees was estimated to be eight hundred years old, while other observers consider the forest growth to indicate an age of at least 1000 years. But it is well known that it requires several generations of trees to pass away before the growth on a deserted clearing comes to correspond with that of the surrounding virgin forest, while this forest, once established, may go on growing for an unknown number of thousands of years. The 800 or 1000 years estimate from the growth of existing vegetation is a minimum which has no bearing whatever on the actual age of these mounds, and we might almost as well attempt to determine the time of the glacial epoch from the age of the pines or oaks which now grow on the moraines.

The important thing for us, however, is that when North America was first settled by Europeans, the Indian tribes inhabiting it had no knowledge or tradition of any preceding race of higher civilization than themselves. Yet we find that such a race existed; that they must have been populous and have lived under some established government; while there are signs that they practised agriculture largely, as indeed they must have done to have supported a population capable of executing such gigantic works in such vast profusion—for it is stated that the mounds and earthworks of various kinds in the State of Ohio alone amount to between eleven and twelve thousand. In their habits, customs, religion, and arts they differed strikingly from all the Indian tribes; while their love of art and of geometric forms, and their capacity for executing the latter upon so gigantic a scale, render it probable that they were a really civilized people, although the form their civilization took may have been very different from that of later people subject to very different influences, and the inheritors of a longer series of ancestral civilizations. We have here, at all events, a striking example of the transition, over an extensive country, from comparative civilization to comparative barbarism, the former having left no tradition, and hardly any trace of influence on the latter.

As Mr. Mott well remarks: Nothing can be more striking than the fact that Easter Island and North America both give the same testimony as to the origin of the savage life found in them, although in all circumstances and surroundings the two cases are so different. If no stone monuments had been constructed in Easter Island, or mounds, containing a few relics saved from fire, in the United States, we might never have suspected the existence of these ancient peoples. He argues, therefore, that it is very easy for the records of an ancient nation's life entirely to perish, or to be hidden from observation. Even the arts of Nineveh and Babylon were unknown only a generation ago, and we have only just discovered the facts about the mound-builders of North America.

MEXICAN AND PERUVIAN REMAINS.

But other parts of the American continent exhibit parallel phenomena. Recent investigations show that in Mexico, Central America, and Peru, the existing race of Indians has been preceded by a distinct and more civilized race. This is proved by the sculptures of the ruined cities of Central America, by the more ancient terra-cottas and paintings of Mexico, and by the oldest portrait-pottery of Peru. All alike show markedly non-Indian features, while they often closely resemble modern European types. Ancient crania, too, have been found in all these countries, presenting very different characters from those of any of the modern indigenous races of America.†

THE GREAT PYRAMID OF EGYPT.

There is one other striking example of a higher being succeeded by a lower degree of knowledge, which is in danger of being forgotten because it has been made the foundation of theories which seem wild and fantastic, and are probably in great part erroneous. I allude to the Great Pyramid of Egypt, whose form, dimensions, structure, and uses have recently been the subject of elaborate works by Prof. Piazzi Smyth. Now, the admitted facts about this pyramid are so interesting and so apposite to the subject we are considering, that I beg to recall them to your attention. Most of you are aware that this pyramid has been carefully explored and measured by successive Egyptologists, and that the dimensions have lately become capable of more accurate determination owing to the discovery of some of the original casing-stones and the clearing away of the earth from the corners of the foundation, showing the sockets in which the corner-stones fitted. Prof. Smyth devoted many months of work with the best instruments in order to fix the dimensions and angles of all accessible parts of the structure; and he has carefully determined these by a comparison of his own and

* Journ. of Roy. Geog. Soc., 1870, pp. 177, 178.

* Wilson's "Prehistoric Man," 3d ed. vol. ii. pp. 123-130.

† Ibid., pp. 125, 144.

all previous measures, the best of which agree pretty closely with each other. The results arrived at are—

1. That the pyramid is truly square, the sides being equal and the angles right angles.

2. That the four sockets on which the four first stones of the corners rested are truly on the same level.

3. That the direction of the sides are accurately to the four cardinal points.

4. That the vertical height of the pyramid bears the same proportion to its circumference at the base, as the radius of a circle does to its circumference.

Now all these measures, angles, and levels are accurate, not as an ordinary surveyor or builder could make them, but to such a degree as requires the very best modern instruments and all the refinements of geodetical science to discover any error at all. In addition to this we have the wonderful perfection of the workmanship in the interior of the pyramid, the passages and chambers being lined with huge blocks of stone fitted with the utmost accuracy, while every part of the building exhibits the highest structural science.

In all these respects this largest pyramid surpasses every other in Egypt. Yet it is universally admitted to be the oldest, and also the oldest historical building in the world.

Now these admitted facts about the Great Pyramid are surely remarkable and worthy of the deepest consideration. They are facts which, in the pregnant words of the late Sir John Herschel, "according to received theories ought not to happen," and which, he tells us, should therefore be kept ever present to our minds, since "they belong to the class of facts which serve as the clue to new discoveries." According to modern theories, the higher civilization is ever a growth and an outcome from a preceding lower state; and it is inferred that this progress is visible to us throughout all history and in all the material records of human intellect. But here we have a building which marks the very dawn of history—which is the oldest authentic monument of man's genius and skill, and which, instead of being far inferior, is very much superior to all which followed it. Great men are the products of their age and country, and the designer and constructors of this wonderful monument could never have arisen among an unintellectual and half-barbarous people. So perfect a work implies many preceding less perfect works which have disappeared. It marks the culminating point of an ancient civilization, of the early stages of which we have no record whatever.

HIGH DEVELOPMENT OF ANCIENT MEN.

The three cases to which I have now adverted (and there are many others) seem to require for their satisfactory interpretation a somewhat different view of human progress from that which is now generally accepted. Taken in connection with the great intellectual power of the ancient Greeks—which Mr. Galton believes to have been far above that of the average of any modern nation—and the elevation, at once intellectual and moral, displayed in the writings of Confucius, Zoroaster, and the Vedas, they point to the conclusion, that, while in material progress there has been a tolerably steady advance, man's intellectual and moral development reached almost its highest level in a very remote past. The lower, the more animal, but often the more energetic types, have however always been far the more numerous; hence such established societies as have here and there arisen under the guidance of higher minds, have always been liable to be swept away by the incursions of barbarians. Thus in almost every part of the globe there may have been a long succession of partial civilization, each in turn succeeded by a period of barbarism; and this view seems supported by the occurrence of degraded types of skull along with such "as might have belonged to a philosopher"—at a time when the mammoth and the reindeer inhabited southern France.

Nor need we fear that there is not time enough for the rise and decay of so many successive civilizations as this view would imply; for the opinion is now gaining ground among geologists that palæolithic man was really preglacial, and that the great gap—marked alike by a change of physical conditions, and of animal life—which in Europe always separates him from his neolithic successor, was caused by the coming on and passing away of the great ice age.

If the views now advanced are correct, many, perhaps most, of our existing savages are the successors of higher races; and their arts, often showing a wonderful similarity in distant continents, may have been derived from a common source among more civilized peoples.

IMPREGNATION OF THE BOA-CONSTRICTOR.

S. LOCKWOOD, in the *American Naturalist*, makes some interesting observations on the eggs of the above animal—in fact, he puts a very important question to the physiologist. He says: "My friend Dr. Kunze has shown me an infertile egg of a boa which he lately obtained at the Central Park menagerie. The boa laid twenty-one eggs, each about the size of a hen's egg. The animal made the deposit in sight of her keeper and others. She laid two fertile eggs, and then a sterile one, in regular succession; each third egg was sterile. The fertile eggs had each a young boa within. One came out of its shell immediately after being laid, but soon died. All the others died within their shells. The sterile eggs were albuminous throughout, and cut like cheese and smelled like sperm-oil. Could this be the balance of an impregnation received the year before?"

THE CAT AS A SUBSTITUTE FOR THE CARRIER PIGEON.

IT seems that the Belgians have formed a society for the mental and moral improvement of cats. Their first effort has been to train the cat to do the work now done by carrier pigeons. The most astute and accomplished scientific person would have his ideas of locality totally confused by being tied up in a meal-bag, carried twenty miles from home, and let out in a strange neighborhood in the middle of the night. This experiment has, however, been repeatedly tried upon cats of only average abilities, and the invariable result has been that the deported animal has re-appeared at his native kitchen-door the next morning, and calmly ignored the whole affair. This wonderful skill in travelling through unfamiliar regions, without a guide-book or a compass, has suggested the possibility of cats being used as special messengers. Recently thirty-seven cats residing in the city of Liege were taken in bags a long distance into the country. The animals were liberated at two o'clock in the afternoon. At 6.48 the same afternoon one of them reached his home. His feline companions arrived at Liege somewhat later, but it is understood that within twenty-four hours every one had reached his home. It is proposed to establish, at an early day, a regular system of cat communication between Liege and the neighboring villages.—*Popular Science Review.*

TESTIMONY FOR EVOLUTION.

As it is undoubtedly of great interest to note such evidence as geology may afford in support of the theory of descent with modification, we may call attention to some recent palæontological researches in this direction by Drs. Neumayr and Paul. Their studies have dealt with certain species of lacustrine gasteropods from the Upper Neogene deposits of Western Slavonia, which are probably equivalent in age to some of our Pliocene deposits. The lacustrine beds consist for the most part of sands and clays, with seams of lignite, extending to a thickness of about 2000 feet. They form two great groups, each having a distinctive fauna: the lower stage, known as the Congeria beds, corresponding to those of the Vienna basin, offers evidence of having been laid down in brackish water, but the beds pass upward into fresh-water deposits; while the upper group, known as the Paludina beds, is purely lacustrine. This Paludina series may be divided into three principal groups, and subdivided into eight minor groups or zones, each with a characteristic fauna. These beds have yielded no fewer than forty distinct forms, or so-called species, of the genus Vivipara, or Paludina; and by carefully comparing these the authors are able to establish connecting links, showing clearly the derivation of the more recent from the older forms. The divergence between the various types is so great that in some cases the extreme terms of the series have actually been placed in distinct genera. By thus tracing the descent of the later forms of Vivipara from their ancestors in the older beds, a pedigree is established comparable with that of the well-known case of the descent of the horse from Hipparion. Neumayr and Paul's original paper will be found in the *Abhandlungen* of the Vienna Geological Reichsanstalt, and an abstract of the memoir has been communicated to *Nature* by Prof. Judd.—*The Academy.*

THE ASH-SHOWERS OF ICELAND.

PROFESSOR NORDENSKIOLD says in the *Geological Magazine*: "Our knowledge of these eruptions, however, unfortunately is not as yet founded on any scientific examination; and it is perhaps the less necessary to repeat here the interesting accounts of those grand phenomena that have appeared in the newspapers, as I expect to have an opportunity another year of returning to the subject, since the region will probably be visited next summer by a distinguished geologist, well acquainted with the natural history of Iceland. I will only mention that the eruption began in the month of December, 1874, and then continued with shorter or longer intervals from numerous craters situated in the interior of the country, partly on Dyngjufjäll, partly in the northern part of Vatnajökul, or in the region between these enormous glaciers and the great snow-clad volcano Herdabreid. The most plentiful ash-rain on Iceland itself took place in consequence of an eruption which began at the place last mentioned on March 29, and the ashes which fell in Scandinavia probably belong to the same point of time, in which case less than twenty-four hours was required for carrying the ashes from Iceland to Scandinavia; that is, for their passing over a distance of 200 Swedish miles, or 2000 kilometres. Geological science has recorded many accounts of the fall of volcanic ashes, where the ashes have been carried by the wind to very remote regions; among others that ashes had already been carried, a couple of centuries ago, from Iceland to Bergen, on the west coast of Norway; but no example of so extensive a spreading of volcanic ashes with the wind, as from Iceland to the east coast of Sweden, is previously known. On Iceland the ashes fell in such quantity that at some places they covered the ground to a depth of 6 inches, and destroyed the pastures. The cloud of ashes was for several hours so close that the sunlight could not penetrate it, and lights required to be kindled in the middle of the day. The ashes must also have fallen in considerable quantity in the sea between Iceland and Norway, and on its bottom there are doubtless found places where the remains of such falls collect during centuries without any considerable mixture of foreign matter. Here must be formed thick beds of volcanic ashes, which in the course of geological ages gradually harden together, and are metamorphosed to rocks of nearly the same composition, and therefore also strongly resembling those which in molten form burst forth from the interior of the earth; and we have here, doubtless, the key to the extension over boundless regions of the earth of stratified so-called volcanic rocks, a circumstance to which I have already long ago drawn attention with reference to the occurrence of plutonic rocks regularly stratified in the polar regions."

THE PLANET VENUS.

DURING the last fortnight we have often seen in the streets of Boston little knots of people gazing intently at the heavens, attracted by the novel spectacle of "a star shining at noonday." This was all that most of them seemed to know about it, only a few being able to tell the name of the presumptuous orb that ventured to dispute possession of the sky with the king of day. Many of our readers have doubtless had their attention drawn to the same "wonder in the heavens," and are aware that it is the planet Venus, now at its maximum brilliancy. Some of them have probably seen it "flaming in the forehead of the morning sky," an hour or two before sunrise; and we can assure those who have not enjoyed the sight that it is well worth getting out of bed at that unseasonable time to witness it. The planet shines with a pure white light of indescribable beauty, and of such intensity that it casts a distinct shadow of the window frame upon wall or floor. Venus is always the brightest of the starry host, but it is only at intervals of seven or eight years that it attains this extraordinary splendor.

Next to the moon, which is the immediate handmaid of the earth, Venus is our nearest neighbor in the solar system. Her mean distance from the sun is about sixty-six million miles, and at her closest approach to us she is only some twenty-five million miles off. That is a very respectable distance according to our terrestrial standards, but it seems quite insignificant to the astronomer, who has to deal with intervals of space so enormous that a hundred million miles comes to appear a mere handbreadth by comparison.

It is not, however, when Venus is nearest that we see her to the best advantage, for she is then between us and the sun, with her dark side turned towards us. At that point in her orbit, indeed, we do not see her at all, unless she happens to pass *exactly* between us and the sun, as in the so-called transits of Venus, when the planet appears as a small, round black spot crossing the solar disk. Such a transit, as our readers know, occurred in 1874; another will take place in 1882, and then more than a century must elapse before the phenomenon is repeated. It is when the planet is nearly 40 degrees away from the sun that she is brightest. The telescope shows that she then has the form of the moon when it is three or four days old, or a disk about one fourth illuminated; but the degree of illumination and the distance bear the most favorable relation to each other. She goes on like the moon, rounding out towards "the full," but she is receding from the earth so rapidly that her brightness decreases.

As Venus is our next-door neighbor among the stars, it is natural to suppose that we are pretty well acquainted with her, but we really know very little about her. She is of nearly the same size as the earth, her diameter being about 7600 miles, and her density seems to be a trifle less than that of our globe; but there are few other facts concerning her physical condition which are settled beyond a doubt. Her very brightness is the chief obstacle in studying her physiognomy. Her disk is so dazzling and uniformly brilliant that it is difficult to discern any spots by which her period of rotation can be determined; but observations made in the last century, and quite generally accepted by astronomers, indicate that this is about 23½ hours, or a little less than that of our earth. The same observations make the inclination of her axis much greater than that of the earth's, so that the changes of the seasons over most of her surface would differ materially from ours. It is pretty certain that she has an atmosphere denser than ours, and there is reason to believe that her surface is diversified by mountains, which are perhaps higher than any on the earth.

It is a curious fact that it is a disputed question whether Venus has a moon or not. Several observers, especially towards the middle of the last century, saw what they supposed to be such a satellite, and even calculated its orbit; but the greatly improved telescopes of our day have failed to detect it. The problem seems to us one of the most perplexing in the annals of astronomical science. It is difficult to believe that the satellite, if it exists, could elude the vigilance of observers, especially at the transits of Venus, when it ought to be seen as a smaller black spot accompanying the planet on its path across the sun. On the other hand, after a careful examination of all the alleged observations of such a body, it is extremely difficult to account for them. Attempts have been made to explain them away as mere reflections of the planet itself, or optical "ghosts" produced within the telescope; but though it is possible to dispose of some of the observations in this way, there are others to which it is not easy to apply this theory. Dr. F. Schorr, a German astronomer, has lately published a treatise which is an elaborate and zealous plea in behalf of the hypothetical satellite; but from the reviews of the book in foreign journals we judge that it will not make many converts to the author's theory. The mystery must remain for the present unsolved. We must have more satisfactory evidence of the existence of the moon, or we must believe that those who supposed they saw it were somehow deceived, though it is impossible for us to understand how the illusion was produced.—*Boston Journal of Chemistry.*

FRENCH ACADEMY OF SCIENCES.

SEPTEMBER—OCTOBER.

On the Poisonous Action of Boracic Acid. By M. Peligot.—The author shows that very dilute solutions of boracic acid cause the leaves of plants to become yellow and the plants eventually to die. He calls attention to the system of preserving meat by similar solutions, and suggests that if the latter be so poisonous to plants, they must exercise a somewhat similar effect upon animals and living organisms generally. Experiments are to be conducted in order to determine this.

On Capillary Affinity. By M. Chevreul.—The author, to 154 grains of water containing 9.67 grains of strontium, added litharge. At the end of 72 hours he noted that 9.37 grains of strontium were precipitated on the oxide of lead, and that 12 grains had entered into solution. Lime and baryta give analogous effects, which the author refers to capillary affinity. At the same time he points out errors which the analyst is likely to fall into through the circumstance. On precipitating in a complex liquid peroxide of iron or aluminium by ammonia, it is easy to remove a portion of the lime therein and so to obtain inexact results. M. Chevreul thinks that only the spectroscope can furnish precise indications on the value of the separations realized.

On the Extraction of Gallium.—M. Lecoq de Boisbaudran announces that he has simplified his mode of preparing the new element. The gelatinous precipitate given by zinc to the acid solution of the natural ore is dissolved in hydrochloric acid and treated with sulphuretted hydrogen. Carbonate of soda added in portions in the filtered liquor allows of isolating the oxides with which gallium is associated. The latter transformed into sulphates abandon to the hot water the subsalt of gallium, whence the oxide of the metal is precipitated by a prolonged current of carbonic acid. Nothing further remains than to purify the product.

Indian Corn a Phylloxera Remedy.—M. Gachez states that vines between the rows of which red Indian corn (maize) is sown are completely protected from the ravages of the phylloxera. The insect abandons the vine to attack the roots of the corn.

On Distilling by Sun Heat.—M. Mouchot recently exhibited a new disposition of his solar boiler, whereby in fifteen minutes he converted a quart of wine into brandy, which, so far from possessing the disagreeable taste of alcohol obtained from wine by ordinary processes, has the flavor of the best kirsch (cherry brandy). By placing flowers in the boiler, essences and perfumes were made.

On the Siphoning of Gases.—M. F. Bellamy states that gases on the surface of mercury may be siphoned away by capillary cubes which present a large number of bodies, such as bands of filtering paper, strips of leather, shavings, bundles of rusty iron wire, of sewing thread, etc. Hydrogen, he states, is quickest removed. All the phenomena observed are those of gaseous osmosis.

SPECIFIC HEAT OF GASES.

MM. KUNDT and WARBURG have determined experimentally the ratio of the two specific heats of mercury vapor, which has been supposed by chemists to consist of monatomic molecules. According to the Kinetic theory of gases, supposing the gaseous molecule to consist of only one atom, the relation of the two specific heats (as Clausius has shown) would be 1.666. The lower number obtained by experiment for several gases may probably be explained by the complete constitution of their molecules. The method here employed was to produce a sound in two glass tubes placed end to end, and containing, one mercury vapor, the other air. Having introduced powder into the tubes they observed the distances between the nodes of vibration. Applying the formula for the velocity of sound which includes the densities, temperatures, and the ratio of the specific heats, and taking as the value of this ratio in the case of air, the number 1.405, they obtain, for mercury vapor, the number 1.67, which may be considered as fully in accord with the number 1.666 furnished by theory.—*Pogg. Ann.*—*Nature.*

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MacCord.

No. XXIX.

It has been previously remarked that it is sometimes desirable to perform the converse of the operation of development: that is to say, to find the form which will be assumed by a line drawn upon a developed surface, when that surface is rolled up again into its original form. The method of doing this may be easily deduced from the means employed for finding the developed form of a line drawn on the original surface. The general principle of the processes used for that purpose depends upon our knowing the positions of certain lines of the surface when developed, which lines either cut or touch the line whose developed form we wish to find. It will readily appear, then, that if we draw on the development a series of lines of which we do know the position when the surface is rolled up, and also cutting or tangent to the given line, we can find the position of the points of intersection or tangency, and thus of the line after forming the surface which was developed.

This is illustrated in Fig. 251, in which A A B B is the development of the surface of a cylinder. Upon this is drawn the parabola, A M B, of which A is the vertex and A A the axis, whence the curve is drawn to pass through B by the method of Fig. 155. This rectangle will when rolled up form the cylinder shown in front elevation and in plan, Fig. 252, at the left. In order to find the form of the curve on this cylinder, we divide the rectified base, B B, into equal parts at the points 1, 2, 3, etc.; then, assuming that the cylinder is cut along the right-hand element $a' b'$, corresponding to the left-hand side A B of the development, we divide the circumference in the plan into the same number of equal parts, beginning at a', by the points, which both in the plan and elevation are numbered 1, 2, 3, etc., just as in the development. In the latter are erected ordinates at these points to meet the parabola, and in the front elevation the lengths of these ordinates are measured up from the base on the corresponding elements.

It wi.l be seen that the curve as thus determined has a resemblance to the helix; but it will also be observed that though the rate at which the point which traces it travels round the cylinder is uniform, its linear advance is accelerated from bottom to top; and the curve is called in consequence a helix of increasing pitch.

There is also drawn on the development a circle, which when rolled up on the cylinder will assume some form to be ascertained in a similar manner. The extreme limits may be found by drawing vertical tangents at E and F, the extremities of the horizontal diameter. These will become elements of the cylinder; and since the vertical diameter will become the left-hand element $c\ d$, we find first the arc of the circumference of the base, which is equal to the radius E O of the given circle, and set it off on each side of c' in the plan, as $c'\ e'$, $c'\ f'$. The point e will then be found directly under e', and on the level of E F; and the vertical element through e will be tangent to the curve. The highest and lowest points, H and L, being on the vertical diameter, will appear in the front view at h and l on the left-hand element; and the best proceeding in order to find other points is to divide E O into equal parts, as at 1, 2, the verticals through which points will, like the others, become elements. They cut the given circle at G and I, and the corresponding points, g, i, are found at the same altitudes, and perpendicularly under $g'\ i'$ in the plan, the latter points subdividing the arc $c'\ c'$ into equal parts, as 1 and 2 divide E O.

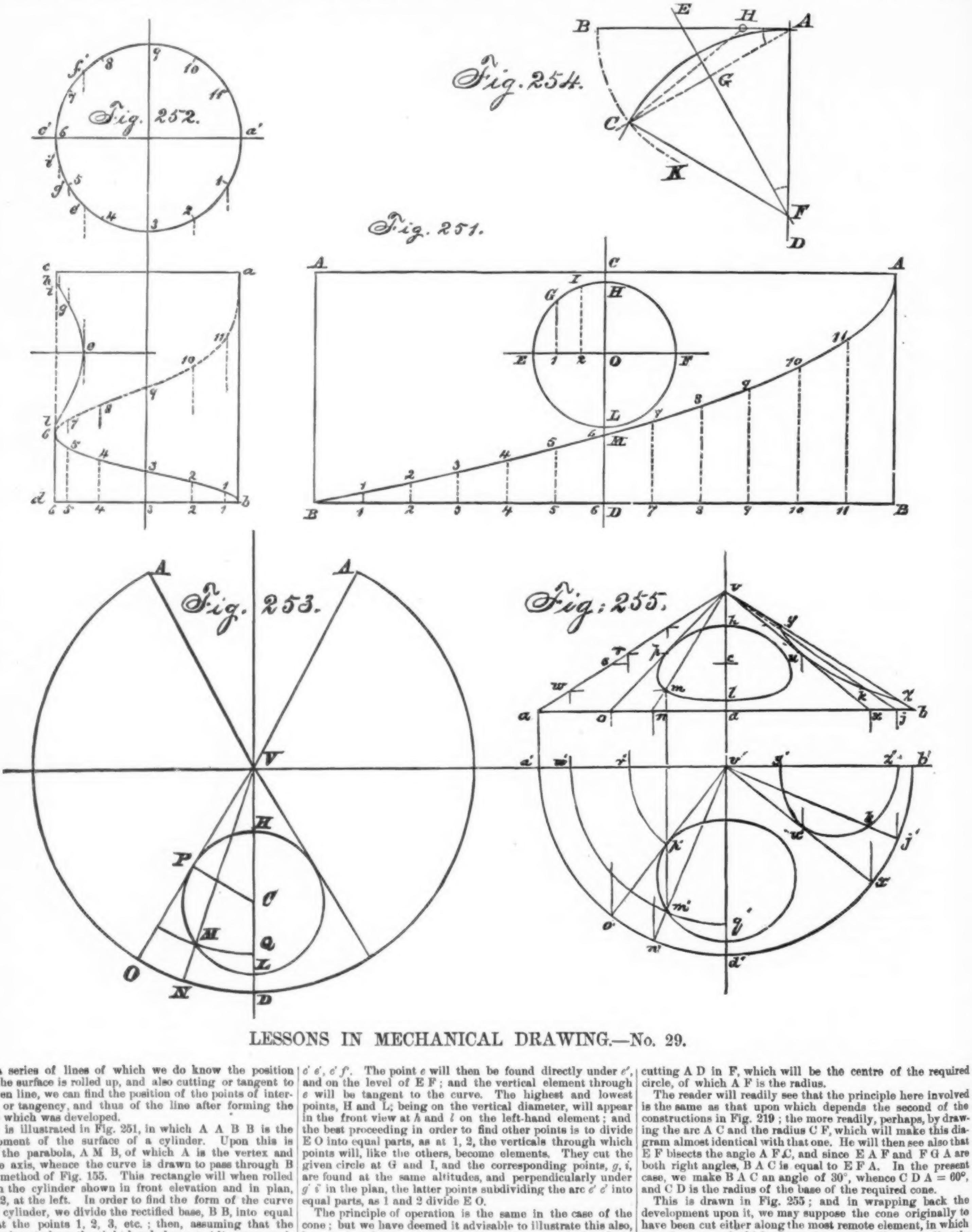
The principle of operation is the same in the case of the cone; but we have deemed it advisable to illustrate this also, because in subsequent operations it will be found of perhaps greater practical utility than the preceding one.

In Fig. 253 we have the development, upon which is described a circle, its centre C being for symmetry's sake on the bisecting line of the angle A V A. Now the slant height of the cone we know is A V; but if the development alone is given us to start with, we must find the radius of the base. Since the circumference of that base must be equal to the arc A D A, the readiest means of finding its diameter, or rather its radius, is by first subdividing A D, the half of this arc, into three equal parts: this must be done by trial and error, with a pair of dividers, there being no geometrical means of trisecting an angle. Then the rectification of the third part of A D thus found will give the length of one sixth part of the circumference of the required circle; we have next to find an arc whose length shall be equal to this rectification, and of such a radius that the arc shall subtend an angle of 60°. This may be done graphically by the process shown in Fig. 254. Let A B be a right line of a given length; then to find an arc of equal length and subtending a given angle, we first draw A D perpendicular to A B at A; then make A H = ¼ A B, and with centre H and radius H B describe an arc B K. Make the angle B A C equal to half the given angle, and draw A C to cut B K in C; then bisect A C by a perpendicular E F, cutting A D in F, which will be the centre of the required circle, of which A F is the radius.

The reader will readily see that the principle here involved is the same as that upon which depends the second of the constructions in Fig. 219; the more readily, perhaps, by drawing the arc A C and the radius C F, which will make this diagram almost identical with that one. He will then see also that E F bisects the angle A F C, and since E A F and F G A are both right angles, B A C is equal to E F A. In the present case, we make B A C an angle of 30°, whence C D A = 60°, and C D is the radius of the base of the required cone.

This is drawn in Fig. 255; and in wrapping back the development upon it, we may suppose the cone originally to have been cut either along the most remote element, in which case the curve of which we are in search will appear directly in front, or along the left-hand element $a\ v$, in which case it will appear on the opposite or right-hand side. We have in the figure drawn it in both positions; but the process of finding it is the same wherever we locate it.

The element V D will in one case be seen as $v\ b$, in the other as $v\ d$; but the actual distances V H, V L, from the



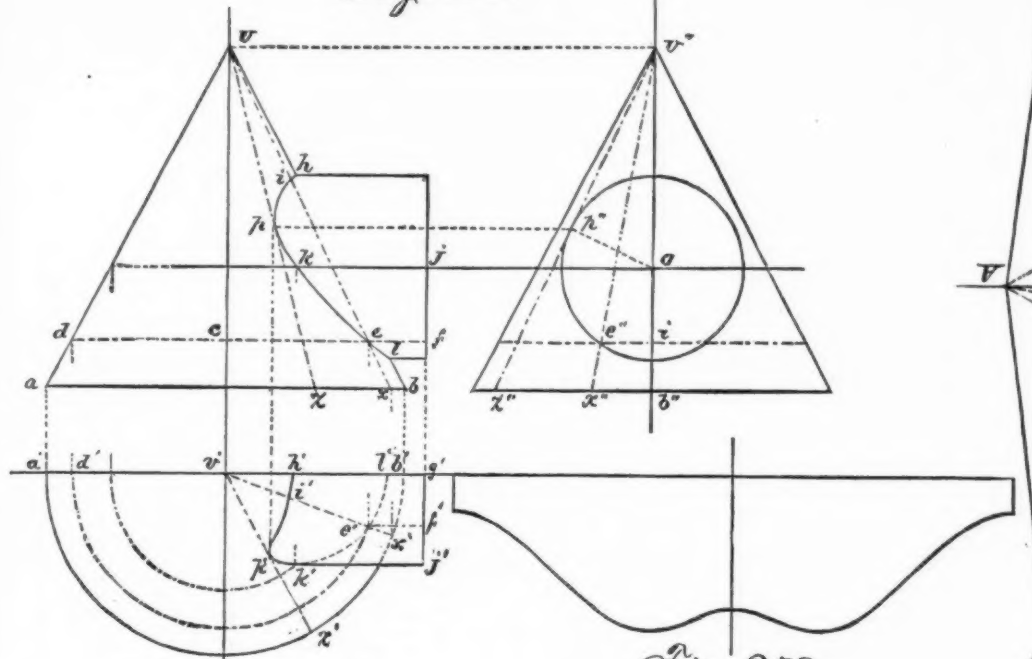
LESSONS IN MECHANICAL DRAWING.—No. 29.

vertex to the highest and lowest points will be the same in either. So we set off $v\,y$ = V H, and $v\,z$ = V L, which will give the actual positions of these points if the curve be drawn on the right, and the altitudes of $h\ l$ their positions if it be drawn in front. Make the arc $d'\ o'$ = D O, then $v'\ o'$, whence in the front view $v\ o$ will be the position of the element of tangency corresponding to V O, tangent to the circle. In the development, draw C P perpendicular to V O, to determine P the point of tangency: set off $v\ r$ = V P, and r is the altitude of this point on the cone, which is p or w, according to whether we are drawing the curve in front or at the side. In the latter case, we set off the arc $b'\ x'$ = $d'\ o'$ to locate the element of tangency $v'\ x'$, or in the front view $v\ x$; on the latter we then find w by drawing the horizontal through r as above explained, after which we drop a vertical from u to find u' on $v'\ x'$, if we wish to draw a top view of the curve; we may proceed, whatever the line is which is originally drawn on the development. We will next take the case of intersection presented by a cone and a cylinder whose axes meet at right angles, as shown in Fig. 256. The upper and lower elements of the cylinder intersect $a\,b$, the right-hand element of the cone, at the points h and l, seen in plan at h' and l'. Now, if we cut both cone and cylinder horizontally across by a plane at the height c, for instance, the section of the former will be a circle whose radius is $c\,d$. This plane will also split off a segment from the lower side of the cylinder, whose breadth will be twice $e''\ i$ in the end view, and the lines of the section on the surface will be two horizontal elements, one of which will be seen in the front view as $f\ e$, and in the top view as $f'\ e'$, its position there being found by setting off $g'\ f'$ equal to $i\ e''$. In this top view we see that the circle on the cone meets this right line on the cylinder in e', may be used to locate a valuable limit to the curve, by drawing $v''\ z''$ tangent to the circumference of the cylinder in the end view, finding the point of tangency by dropping the perpendicular $o\ p''$ upon it from the centre; then draw the same element in the other views, as $v'\ z'$, $v\,z$; the latter will be tangent to the curve of intersection in the front view, and the former in the top view: p' will be of course on $v'\ z'$, and as far below the centre line as p'' is to the left of it in the end view; or we may find this point of tangency in either of the methods previously explained.

We give in Figs. 257 and 258 the developments of the cone and the cylinder respectively, but leave the construction to be made by the student, who ought by this time to be able to apply the methods by which the curves are determined without assistance.

Moreover, he is again respectfully reminded that these dia-

Fig. 256.



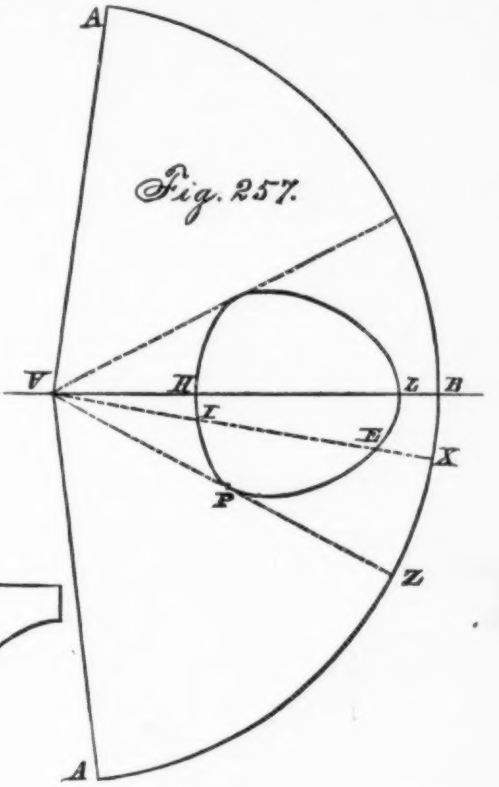
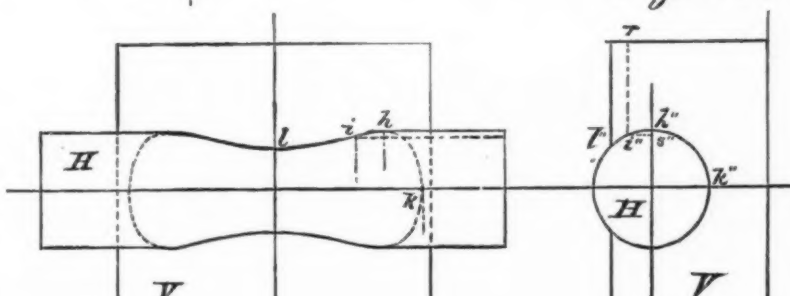


Fig. 258.



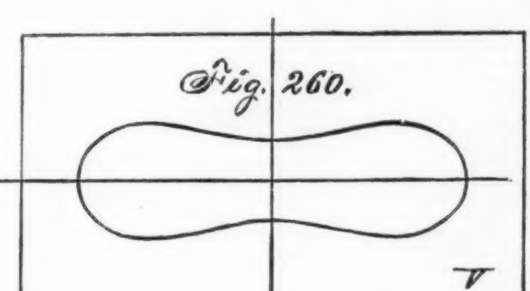
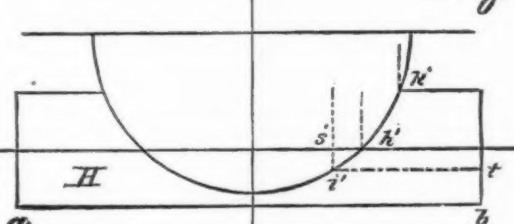
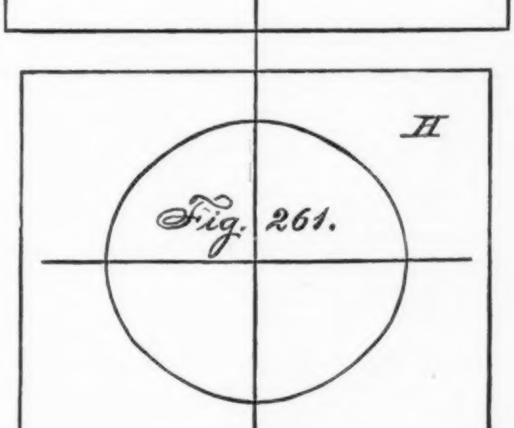


Fig. 259.





LESSONS IN MECHANICAL DRAWING.—No. 29.

z' and y' will there also appear on $v'\ b'$ under z and y. The point c corresponding to C the centre of the circle in the development, is found on $v\ d$ by making $v\ s$ = V C and drawing a horizontal through s. If we draw any element as V N, set off $d'\ n'$ = D N, erect a vertical at n' to find n, draw $v'\ n'$ and $v\ n$; then the point m corresponding to M may be found by setting off $v\ w$ equal to V M, and drawing a horizontal through w to cut $v\ n$. In the view at the side we would make $b'\ j'$ = D N, and thus locate the element $v'\ j'$, or in the front view $v\,j$, on which the point k corresponding to M will appear on the level of w, and k' is vertically under it on $v'\ j'$.

Otherwise, projecting w to w' on $a'\ v'$, describe the circle with radius $v'\ w'$, cutting $v'\ d'$ in q'. Also describe an arc about V with radius V M, cutting V D in Q; set off the arc $q'\ m'$ = Q M, to find m', which projected up to $w\,m$ will give the position of m in the front view.

In this manner we may find any number of points; and thus which we project up to $d\,f$, thus fixing the point e of the intersection. By passing a horizontal plane through the axis of the cylinder, or, what is the same thing, drawing on its surface the nearest element, $j\,k$, and on the cone a horizontal circle at the same level, we may in a similar manner determine k' and k, and so by repetition locate as many points as we think necessary for the accurate delineation of the curve of intersection.

But we may also proceed in another manner. Thus, if in the end view we draw the element $v''\ x''$, passing through e'', then draw it in the top view, where x' will be as far below the centre line as x'' is to the left of b'', and then in the front view, where x in the base is vertically over x', we shall also determine e by the intersection of $v\,x$ with $d\,f$ the horizontal at the level of e''; or e' may be found by drawing the circle with radius $v'\ d'$ = $c\,d$ to cut $v'\ x'$, and e found by projecting e' up to either the horizontal or the element $v\,x$. This method grams are not introduced for him to *copy*. We have endeavored to give him an insight into the operations of constructing these intersections and developments by an explanation of principles. Illustrative diagrams were necessary to the clear setting forth of these principles, and they have been selected of such proportions as would make the figures as distinct as possible. But the reader is warned against associating the construction with the figure; for if the conditions be changed—as, for example, by altering the relative sizes or positions of the intersecting solids—the result may be the complete changing of the whole appearance of the figure. And the best possible exercise for the student will be found in making such changes, in assuming proportions widely differing from those given, in varying the positions in which the solids are placed, and, in short, depending as little as may be upon the engravings. The latter may be used as aids in studying the methods used; let these be mastered, one by

one, step by step, until a clear idea is gained of the whole process and its reasons. Then lay them aside, and make a diagram without reference to them if possible, and if not, refer to them only to remove a doubt, or to refresh the memory in regard to a detail of the process. Practice of this kind is far more satisfactory to the ambitious student, and more beneficial to any one, than copying. And it may not be amiss to add, that it is advisable for the beginner in such work to make his diagrams on a liberal scale. If they be made too small they are very apt to become confusing on account of the crowding together of the lines used in construction, which renders it difficult to trace their relations to each other, so that one who is not perfectly familiar with the operations in progress may become utterly bewildered. Nor is it at all necessary to take the time necessary to ink in and make a finished drawing of every exercise undertaken. On the contrary, that time would be more advantageously employed in working out, on any scrap of paper or on a slate, without too minute attention to rigid accuracy, a greater number of varied examples. Nothing serves a better purpose in fixing the principles, the steps and the reasons for those steps, of the different processes, firmly in the mind. In a word, it is the sure road to thoroughness and to a mastery of the subject. But this comparatively rude manner of executing the problems should not be pursued to the exclusion of practice in accurate work also. It is not too late to say—nor will it ever be—that it is not sufficient to know how a thing ought to be done: that is necessary, but in addition there must be acquired the ability to do it, and to do it well. And this can be done only by repeated and careful attempts; so that after gaining, in the manner above pointed out, a clear and confident understanding of these problems, the student should devote some time and more care to the drawing of some of them with the most minute precision.

There are few exercises in the whole range of ordinary practice which call for nicer manipulation in order to give reliable results, or more completely test the command of the operator over his instruments; and they should not be slighted.

In all the examples thus far given, one of the solids has been supposed to penetrate the other in such a way as to go entirely through it if prolonged. But this evidently need not be the case, and in fact we very frequently meet in practice with instances in which two solids intersect, but in such wise that they are only partially "let into each other." An illustration is given in Fig. 259, in which a vertical cylinder is intersected by a horizontal one, very much as in Fig. 241, but with a greater distance between the axes. By referring to the figure above mentioned, it will be seen that had the horizontal cylinder been prolonged, there would have been two distinct curves of intersection, the one on the left being precisely similar to the one shown on the right, but reversed. In the present instance these two curves run into each other—the intersection forming in fact a single continuous line. It is in this circumstance mainly that the difference between the two cases consists; which, however, is sufficiently great to alter the whole appearance of the diagram. The principle, however, of determining the curve is not at all affected; we still proceed by drawing lines, or supposing them to be drawn, upon one surface, in such a way that we can find the points in which they meet certain lines of the other.

Thus, the nearest element of the vertical cylinder appears in the side view at the left-hand side, and is seen to be intercepted by the horizontal cylinder at l'', whence we find l in the front view. Similarly, the highest element of the horizontal cylinder is seen in the top view to pierce the vertical one at h', whence we locate h in the front view. In the top view also we see that the most remote element of the horizontal cylinder meets the vertical one at k', which in its turn gives us the position of k in the front view.

In finding intermediate points, we may make use of elements of either cylinder at pleasure. For example, in the side view we may draw a vertical element, as $r\,i''$; this pierces the horizontal cylinder at i''. Transfer this point to the top view, by making $s'\,i' = i''\,s''$; then i will be vertically over i', and on the same level as i''. Otherwise, we might have drawn a horizontal element as $t\,i'$ in the top view first, piercing the vertical cylinder at i'. This point must appear in the front view directly over i', and to find its altitude we would transfer i' to the side view by setting off $s''\,i'' = s'\,i$, and thus find i; and in like manner as many more points as are necessary.

In regard to the curve in the front view, it is to be noted that it will have a horizontal tangent at l, and will also be tangent at h, to the upper element of the horizontal cylinder. It then descends, going to the right as far as k, its limit in that direction, where it has a vertical tangent. And we need go no farther in the explanation, since it is evident, from the relations of the two solids, that the curve will be made up of four parts equal and similar to $l\,i\,h\,k$. In making the developments, Figs. 260 and 261, we have supposed the horizontal cylinder to be cut along the nearest element, $a\,b$, for the sake of showing the opening in it as a continuous curve; and as to the vertical one, we have shown but half of it in either view or in the development, since that is sufficient for our purpose of illustrating the peculiarities of the intersection.

The process of development itself presents no novelty, and we therefore simply give the forms of the curves, leaving the student to work out the construction for himself.

THE RADIOMETER OF MR. CROOKES.

In a memoir read before the Academy of Padua by Prof. F. Rosetti, the author concludes his paper as follows: "After the exhibition which I have performed you will be convinced that the radiometer is not an instrument destined merely to attract general attention by reason of its novelty and the curious phenomena which it presents, but that it may serve as a prompt and sensitive thermoscope, and, if used with proper precautions, also as a photometer. It is a novel acquisition for science, both from a theoretical and a practical point of view, and as such it is capable of many applications." The author then describes a modification of the instrument for the purpose of registering the intensity of the solar radiations.

MOVEMENTS PRODUCED BY LIGHT AND HEAT, AND ON THE RADIOMETER OF MR. CROOKES.

By Dr. A. G. Bartbi.

A luminous or thermic pencil which falls upon any body produces a movement due to four causes—(1) Action of the heated sides. (2) Currents of air produced around the heated body itself. (3) Reaction of gases or vapors liberated by heat. (4) Reaction of air heated by contact with the surface upon which the rays fall. On suppressing these causes in the best possible manner, incident light was no longer found to produce attraction or repulsion. These results, however, do not prove that a very feeble impulsive action is not exerted by heat or light.

TYPHOID FEVER.

By A. L. Loomis, M.D.

It is difficult to determine the period of incubation, or length of time the poison must remain in the body before symptoms of the disease are manifest. The history of isolated cases would lead to the conclusion that the period varies from fourteen to twenty days.

The next question that arises is, How does the typhoid poison gain admission to the human body? Undoubtedly there are two principal sources of infection—namely, the air we breathe and the water we drink. A large number of well-authenticated histories have now established the fact, that this fever may be developed by gases which emanate from privies, sewers, etc., which have been the receptacle of excrement from typhoid patients, and also, by drinking water from springs and wells which have become contaminated by matters from adjoining privies and cesspools. It is also now an accepted belief, or rather is regarded as an established fact, that water remains contaminated, though far remote from the point where it came in contact with a defective sewer or water closet.

Soil pipes and sewerage may be defective for a long time, perhaps a year, or even longer, and no case of typhoid fever occur, when suddenly an endemic of typhoid fever breaks out, and careful investigation shows that its development was preceded by the introduction of the excrement of a single individual sick with the disease.

It is the belief of some that milk can convey the typhoid poison, and there is evidence in favor of this opinion; but I think there is stronger evidence that the water in the milk and not the milk itself, is the medium through which the poison is transmitted.

This poison has great vitality. Typhoid fever frequently occurs in the same locality year after year, when the surrounding conditions are favorable to its development. Those conditions which favor its development are more frequently present in the autumn than at any other season of the year, and for this reason it has been called Autumnal fever.

Usually it makes its appearance in a locality, year after year, at about the same time; case after case is developed until entire households and neighborhoods become its victims. Individuals who come to care for the sick may contract the disease, and even persons who visit houses in which the disease is prevailing may afterwards develop the fever, contracting it, not from the sick, but from the infected atmosphere of the locality.

Age must be regarded as a predisposing cause of typhoid fever. It is much more likely to occur in young than in old persons; it occurs most frequently between the ages of fifteen and twenty-five, and is rarely met with in persons over fifty.

There are also individual idiosyncrasies which seem to predispose to this fever. Some contract it upon the slightest exposure to the influence of the poison, while others, frequently brought in contact with it through long endemics, escape. Again, an individual may have repeated attacks of typhoid fever. I have in mind a physician who had typhoid fever four times, the last attack proving fatal. A person who has had typhus or scarlet fever is not likely to have a second attack, but no such immunity follows an attack of typhoid fever. Whatever view we take of the exact nature of the typhoid poison, it has been quite conclusively demonstrated that the typhoid poison differs very essentially from that of other fevers.

From this brief review of the etiology of this fever, we are led to the following conclusions:

First.—That its development is independent of over-crowding, and that it attacks the rich and poor indiscriminately.

Second.—That it may be communicated from one person to another through the excrements which have undergone decomposition after their discharge.

Third.—That an endemic of typhoid fever only occurs where the air or drinking water of the locality has become poisoned by emanations from typhoid excrements which have undergone decomposition, and that, if the fever becomes epidemic, it is a circumscribed epidemic, and not widespread.

Fourth.—That the exact nature of the typhoid fever poison is still unknown.—*Medical Record.*

PLEASURE AND PAIN.

No one knows better than a physiologist how false is the old maxim, "Seeing is believing." He knows that sight and all the other senses *never* show us things as they are. "No kind and no degree of similarity," observes Professor Helmholtz, "exists between the quality of a sensation and the quality of the agent inducing it and portrayed by it." Our sensations tell us nothing of the real nature of the external world. They are mere symbols, every whit as remote as the written word *horse* is from the animal. Their value depends, however, not on the fidelity of their correspondence, for this is null, but on their fidelity at all times to the same impression. The color red is always the color red, the scent of the rose is the scent of the rose, and it is this logical law of identity which gives sensations their value, not the objects which call them forth.

The laws which govern the correspondence of sensations to impressions are those of transmission: in other words, of nutrition. By an accidental variation of structure at some remote epoch, a cranial nerve became sensitive to light; this aided the animal in its efforts to nourish and preserve itself, and strengthened by descent, gave rise to an eye. All the senses arose and were ripened in a similar manner. The stimulus of all of them is their preservative powers.

Now, it is conceded by students of sensations that all of them partake either of the nature of pleasure or of pain. Every impression is either one agreeable or disagreeable. It is further experimentally demonstrable that an agreeable sensation is one which is produced by a sustained and continuous impression up to the point of fatigue, a musical tone, for example; while intermittent and discontinuous impressions, as tones of different pitches, or a flickering light, produce disagreeable sensations. This is the inductive axiom on which Helmholtz bases his celebrated *Lehre der Tonempfindungen.*

Continuous impressions, short of fatigue, mean increased nutrition, repair exceeding waste, preservation strengthening itself. Pleasure, therefore, is physiologically the quality given to sensation by nervous action not in excess of nutrition. The utmost pleasure is derived from *maximum action with minimum waste.*

This generalization offers many instructive corollaries. That which we call the beautiful in art depends upon it. Hogarth drew a "line of beauty," which he found to be that which in its variations most gratifies in outline and form. It is a double curve, and an analysis of it shows it to be that which the muscles of attachment of the eye permit our sight to follow with least labor to themselves. A curve is preferred, in art, to a rectangle, for the same reason. The changes in languages toward greater brevity and sonorousness are dependent upon the rising preference for action with least waste which the use of such idioms implies.

Waste exceeding repair produces a disagreeable sensation reaching as it increases to actual pain. As such it incites to action, but to deterrent and evasive action. Pain is the sensation attendant on the death of the part or system. As the sensation opposed to self-preservation and continuity, as contrary to the first law of existence or motion, it is avoided by all organisms. "To move *from* pain and *to* pleasure is the fundamental law of organic beings," says Professor Bain.

The reader may still be dissatisfied with the explanation, and ask, through the operation of what general law are deterrent sensations, that is, painful ones, associated with waste? Is it an *a priori* arrangement in "the fitness of things"? The question is a proper one, and the reply is, not at all; it is a mere accident; not hardly so much as an accident, but a piece of unconscious choosing. There is nothing in waste itself which necessarily ties it to pain. No god fastened their heads together.

Probably many creatures have been born whose nerves felt pleasure in waste of tissue. Their race is not extinct. "There are," says the Baron d'Holbach in one of his works, "some men who find no pleasure except in actions which will bring them to the gallows." Fortunately, human law generally brings them there; and natural law with infinitely greater certainty soon or forthwith destroys that organism which finds pleasure in waste, but preserves that one which feels pain from waste and transmits this feeling, strengthened by descent, to its progeny. The vices which conceal waste under pleasure, such as alcohol and opium-taking, are the most dangerous ones.

This physiological discussion shows how erroneous that doctrine is which regards pleasure as the negative of pain (pessimism), or pain the negative of pleasure (optimism). The Scandinavian mythology represented Odin, the god of action and effort, as accompanied by his two brothers, Vili and Ve (*Wohl* and *Weh*, pleasure and pain). So in fact every action disturbs the pre-existing relations of nutrition, and brings out agreeable or disagreeable feelings. But as repair is one definite thing and waste is another definite thing, so are the feelings to which they give rise.

This inquiry does not stop with physiology. All religions are founded on some theory of pain. They all teach, to some extent, "purification by suffering;" they all connect pain with sin, death with evil, pleasure with goodness, life with joy. In much that they teach the confusion of sensation and thought is evident; pain and death, as has been shown, cannot have come into the world by sin, for the latter can exist in the intellect alone, while the former is common to all organic existence. But that in which the better religions are right is that in preservation, in continuous life, in obedience to law, lies man's true happiness; that through the destruction of those who disobey, consciously or unconsciously, the race is purified; and that sin, wrongfulness, conscious evil-doing has a punishment as certain, as eternal, as *irrevocable* as Calvin ever taught. The easy doctrine that "bad is good in the making," or that "an error is a truth half seen," finds not a vestige of support before the merciless laws which take no steps backward, hear no prayers, and admit of no moment of truce. The ground-maxim of all morals lies in pleasure and pain, and is embraced in this sentence from Schopenhauer: "No error is harmless; every one will sooner or later do him who harbors it a hurt."—*Medical & Surgical Reporter.*

POWERS OF THE EYE, AND INSTRUMENTATION.

By Dr. Royston-Pigott.

Acuteness of vision varies so considerably in different individuals as to render an average estimate somewhat difficult. I witnessed the accidental detection of Jupiter's satellites (three mentioned) by a person unacquainted with their existence, and this person at my request drew their position on paper, which exactly corresponded with my view of them through a good telescope. Another individual distinguished two children ascending the sunny side of a hill, and the color of their jackets, at a distance exceeding half a mile (also verified with a good opera-glass). The same person could see bullet marks at 500 yards. Another fact was very surprising. I watched from the Ramsgate sands, for a long time, in 1844, a balloon (which had gone off towards Holland), with a small opera glass magnifying about $2\frac{1}{4}$ times. Long after it ceased to be visible to me with this aid, the sailors lounging about kept watching it still, and several saw it distinctly with the naked eye.

Another circumstance is worthy of note. In some persons striations or rows of beads can only be seen when presented to the eye at a certain angle. I recollect every one of a party of gentlemen at my house, except one, saw distinctly a microscopic field of this nature. I then said to him, jocularly, "Turn your head on one side," when to his surprise the definition became quite distinct. I have often observed highly skilled opticians perform the very same gyrations.

Mr. Broun, F.R.S., says: "A dark brown hair, .0026 inch wide, 2.5 inches long, was fixed by dots of transparent gum-arabic to the window-pane, and was seen by a young eye, against a N.W. sky, at 36 feet distance; the diameter of the hair subtended an angle of 1″.24 ($1\frac{1}{4}$ seconds of arc). Mr. Broun required it to be placed at 30 feet distance, and this would give a visual angle of 1″.54, a quarter of a second greater.

It may be interesting to the reader to know that a white disk of paper one inch in diameter forms a visual angle of

1″ at 206265	inches	distance, or	5730	yards.
2″ at 103132	"	"	2865	"
3″ at 68755		"	1910	"
6″ at 34378	"	"	955	"
60″ at 3438	"	"	95	"

Now a visual angle of two seconds is equivalent to

A line $\frac{1}{103132}$ inch diameter, distant 1 inch.
A line $\frac{1}{10313}$ " " " 10 inches.

In agreement with this, Mr. Broun states a young eye, he finds, can actually see lines on glass $\frac{1}{10000}$ inch wide, $\frac{1}{25}$ long.

If therefore the 10,000 of an inch can be seen with the naked eye, without a lens, it ought to follow that the 100,000th of an inch ought to be seen by the same acute eye, with a power magnifying ten times.

Now Nobert's lines 112,000 to the inch, probably have interspaces quite as wide as the thickness of the lines (indeed, Mr. Broun's examination of photographs of these lines, as well as my own, confirm this estimate); and therefore the absolute diameter of the lines themselves would be about the 224,000th of an inch. Such a line, or rather, if conceivable,

such a black line as this would, if placed at ten inches distance, subtend an angle of

$\frac{1}{9}''$ very nearly (one ninth of a second).

Viewed with a power of 18, its angle would be

2 seconds.

With a power of 540 the visual angle would be raised to

60″ or 1′

(more accurately $\frac{1}{9.2}$ second, which would give 21.75 instead of 18, and then the power would be 650 instead of 540).

If therefore the lines on Nobert's plate, 112,000 to the inch, were really simple black lines, they ought, with ordinary sight, to be easily distinguishable with a magnifying power of about 600 diameters, and this would make a visual angle thirty times greater than Mr. Broun's result above stated.

But these lines in general are grooves ploughed in glass of a prismatic, round, or irregular section; and since they can only be seen with extremely oblique illumination (looking as it were sideways) by means of the very wide-angled objective generally found necessary, it is probable that the available shadow may be much less than the supposed breadth of the line, and quite indeterminable.

In cutting lines on glass with a diamond, I have been occasionally much surprised with the beautiful little curls or ringlets cut cleanly out of the glass surface; but this only happened when the diamond-holder was rotated into one particular position, and inclined at one particular angle. When, therefore, we are looking at such fine "Nobert" grooves in glass, we are somewhat in the dark as to what kind of object or shadow we are really observing. For if different grooves be cut in glass, forming differently shaped channels in section, whether oval, circular, square, or triangular, a remarkable difference in appearance will be observed when viewed and illuminated obliquely with transmitted light. Nobert's grooves are, as it were, unknown objects, for we know not and never shall know the sectional shape of the hollow rulings that compose them.

UNDERGROUND TEMPERATURE.

Report of Committee read in Mathematical and Physical Science Section of the British Association, Glasgow Meeting.

PROFESSOR EVERETT submitted the report of the Underground Temperature Committee. He began by explaining some of the thermometers which had been used for particular purposes, and afterwards said that the subject which had been under the consideration of the committee was the convection of water in bores and of the means to prevent it. A great many experiments had been made, but they had been all rejected. They had, however, obtained some which were the best that had yet been got. There was an exceedingly deep bore at Sperenberg, about 20 miles from Berlin. It was 4052 Rhenish feet, or 4172 English feet deep, and the bore was almost entirely through rock salt, and full of water, and the temperature at the surface was 7.2 deg. Reamur; at 700 ft. the temperature was 17.2; and at 3390 ft., the deepest point at which reliable observations were obtained, the temperature was 37.2, and that gave 1 deg. Fahr. to 50 Rhenish feet. These observations showed that there was a decided decrease of the rate of increase as they went deeper. The next thing the committee had directed their attention to was flooding, and in that the most careful observations had been made to ascertain the effect of convection, and whether flooding was necessary. The first experiment was made to ascertain whether the water at the bottom of the bore had the normal temperature of the surrounding rock, because if the water at the bottom did not possess that qualification the water in other parts would not. The way in which it was tested was, that when the bore had gone to a certain depth an advance bore was made of smaller diameter; and into that advance bore a thermometer was let down, and the bore then plugged at the place where it communicated with the big bore. The thermometer on being taken out gave a temperature of something more than 36 deg., and the same thermometer let down without the bore being plugged gave a reading of 33 deg. Reamur. Another thermometer of a different construction gave readings similar to those of the other. The committee had under consideration the obtaining of a plug which would effectually separate the water of the bore below from that above, and at the same time be easy to let down and draw up. Great difficulty had been experienced in reference to that point, and that would now be the aim of the committee to secure such an appliance in order to get correct observations. Additional experiments had been made at a place called Swinderby, near Scarle, Lincoln, 2000 ft. deep, which he understood was the deepest bore in the east of England. At that depth the temperature was found to be 79 deg. Fahr., and deducting from that the temperature of the surface—50 deg.—gave a difference of 29 deg. Another observation at 1950 ft. gave a temperature of 78 deg. In addition to these, Mr. Symons had taken observations in a well at Kentish Town for the purpose of determining whether at a given depth—of say 1000 ft.—there was any change of temperature, but as the wire by which the thermometer had been let down had increased in length to an average over the two years of about 5 ft., there was really no reliable result obtained. Favorable observations had also been taken at Angers, in the North of France.

ACTION OF SALICYLIC ACID ON THE BONES.

AT the meeting of the Niederrheinische Gesellschaft in Bonn on December 6th, 1875, Prof. Koster reported the results of his experiments on the action of salicylic acid on the osseous system. Pieces of spongy bone become soft as leather in a few days when placed in a half per cent solution of salicylic acid, while compact bone tissue is very slowly softened. The enamel of the teeth is very slightly affected by it, but the dentine where it is exposed by caries is rapidly destroyed. Dentists have already recognized the evil effects of salicylic acid on the teeth. The increased amount of the salts of lime in the urine soon after salicylic acid has been taken, shows that the acid deprives living as well as dead bone of its lime salts.

TAPE-WORM IN MEAT.

AN article taken from the *Abeille Medicale* points out the danger of eating meat in the half-raw condition, called by some persons "rare," as the ova of the tape-worm are only killed by thorough cooking. Those whose tastes lead them to select meat in this condition are recommended to eat the flesh of the horse, which is less infected by the Tænia than the ox, sheep, or pig.

PLASMA TUBES OF THE HUMAN SKIN.

AXEL KEY and GUSTAVE RETZIUS give a brief statement of the results of their researches on the plasma passages of the skin, especially of the superior extremities. A more complete account of their studies will be found in their work, now passing through the press, "On the Anatomy of the Nervous System and the Connective Tissue." They mention the fact that, besides the true efferent lymphatic vessels, they have discovered in the skin an extended system of large plasma passages communicating with the lymphatic vessels mentioned, and resembling those which they have mentioned and drawn in the last fasciculus of their work, as existing in the mucous membrane of the nose. In the deepest parts of the skin, the plasma passages around the constituent parts (sweat-glands, hair-bulbs, etc.) are relatively large and wide; in the external portions they become more slender but abundant, and they form a fine net-work in the papillæ. They are not limited by the epidermis, however, but cross the papillæ in many places and penetrate into the rête Malpighii. Our authors have, in fact, succeeded in injecting in the rête Malpighii a fine net-work of plasma tubes with compact meshes which fill the intervals between the various cellules in every direction as far as the corneous layer. The intercellular injection is arrested externally by the latter cell layer; but there is a system of passages at the surface of the skin which are so disposed that the injection penetrates the excretory ducts of the sudoriparous glands. With regard to the plasma passages of the rête Malpighii, our authors remark that M. Bizzozero endeavored, several years ago, to prove that the spines of the cells of the rête do not cross each other like the teeth of two wheels, but that these "stachels and riffs" from adjacent cells hang together by their points, leaving small spaces and passages between them. It is quite evident that it is these intervals which K. & R. have injected in the rête Malpighii, and which communicate with the plasma tubes of the dermis itself.—*Nordiskt Med. Arkiv.*

DEAFNESS AS AN INTRACRANIAL DISEASE.

AT the recent meeting in Philadelphia of the Conference of Principals of Deaf-mute Institutions, Dr. Turnbull, of Philadelphia, was invited to speak, and entertained the Conference with illustrations of the external and internal ear. He believed that deafness (excluding cases manifestly due to disease of the apparatus of hearing) is a rare complication of intracranial disease. It is much less common than disease of the optic nerve, extending to the brain substance. One case he had recorded of abscess and tumor in the cerebellum with deafness of one ear. Dr. Jackson, of London, had recorded a tumor of the left cerebral hemisphere, where there was deafness of both ears.

These facts go to prove that the brain of the deaf and dumb is as capable of receiving and retaining any amount of intellectual knowledge as that of his hearing brother or sister, provided it is made available to him by the eye, not by the ear.

DYSPEPTIC ASTHMA.

AT a late meeting of the Berlin Medical Society, Prof. Henoch detailed the histories of several cases of this affection occurring among children, which had come under his observation. The symptoms were alarming dyspnœa, with pallor of the face and lividity of the lips, coldness of the extremities, small and extremely frequent pulse, superficial, and very frequent respiration, and great mental apathy. The affection apparently depended upon disturbance of the digestive functions. There were in all of the cases some tumidity and tenderness in the epigastrium; but in spite of the threatening symptoms, not the least indication of cardiac or pulmonary disease could be found, on repeated and careful examinations. In one case, that of a child of nine months old, in whom there had been constipation and vomiting, great relief was afforded by the application of numerous dry cups to the chest, and recovery from the attack coincided with the eruption of an incisor tooth. The other patients were children of nine years, three months, and two years, respectively, and all were relieved by the action of an emetic or cathartic. Prof. H., although sceptical at first, ultimately came to agree with the opinion expressed by Traube, who saw the first case in consultation; namely, that the disturbance in the stomach excited a reflex vaso-motor spasm in the small arteries, whence followed the coldness of the extremities, imperceptible pulse, stasis in the venous system and right heart, cyanosis, accumulation of carbonic acid in the blood, and dyspnœa. He therefore assigns the name *asthma dyspepticum* to the affection.—*Berl. klin. Woch.*

SUSPENSION IN SPINAL CURVATURES.

AT the recent meeting of the American Medical Association, Dr. Benjamin Lee, of Philadelphia, introduced a little girl, twelve years of age, illustrating the safety and feasibility of suspension in the treatment of spinal curvatures. The apparatus shown was a strong frame-work, from the middle of which was suspended his "spinal swing," being a rope passing over a pulley, carrying at one end a steel bow, to which are attached straps, to support the chin and occiput, and at the other wooden ovals to serve as handles. The head straps being so adjusted as to make equal traction on the chin and occiput in the line of the spinal axis, the patient, taking hold of the handles, drew down upon the rope until her feet were lifted from the floor, and she swung freely, half the weight being supported by the neck, and half by the arms. She then drew herself up hand over hand until her head nearly touched the pulley, and then slowly let herself down again.

A NEW ADHESIVE PLASTER.

A MIXTURE of twenty parts of mucilage and one part of glycerine constitutes an excellent shining and supple plaster, far cheaper than the resin and diachylon, and lasting more than a year without deterioration. Three or four layers of the mixture require to be spread over each other on the linen or other stuff, allowing sufficient intervals for the successive layers to dry.

A VENETIAN surgeon, Dr. Minich, has published a *brochure* on the antiseptic cure of wounds, in which he advocates the employment of sulphate of soda in dressing of wounds (and also against erysipelas), in preference to phenic and salicylic acid. It is much cheaper, and not attended by the inconveniences of these acids. He uses one part of sulphate in nine parts of water, adding one part of glycerine. Dr. Minich shows that happy results have been obtained by this method in Venice in a large number of cases.

ON PREPARING SOME COLORED FIRES (BENGAL LIGHTS) USED IN PYROTECHNY.

By SERGIUS KERN, St. Petersburg.

IN preparing colored fires for fireworks by means of the usual formulæ given in many manuals of pyrotechny, it is often very necessary to know the quickness of burning of colored fires, so as in some cases, as decorations and lances, they must burn slowly, in other cases, as wheels, stars for rockets, and Roman candles, they must burn quicker. Working for some months with many compositions of such kind, I prepared three tables of colored fires (red, green, and violet), where every formula with a higher number burns quicker than a fire with a lower number. For instance, No. 5 burns quicker than No. 6 and slower than No. 4. These tables will, I think, be of much assistance in the preparation of fireworks.

Green-colored fires.

No.	Potassium Chlorate. Per cent.	Barium Nitrate. Per cent.	Sulphur. Per cent.
1.	36	40	24
2.	29	48	23
3.	24	53	23
4.	21	57	22
5.	18	60	22
6.	16	62	22
7.	14	64	22
8.	13	66	21
9.	12	67	21
10.	11	68	21
11.	10	69	21
12.	9.5	69.5	21
13.	9	70	21
14.	8.5	70.5	21
15.	8	71	21

Red-colored fires.

No.	Potassium Chlorate. Per cent.	Strontium Nitrate. Per cent.	Sulphur. Per cent.	Carbon Powder. Per cent.
1.	40	39	18	3
2.	32	46	19	2
3.	27	51	20	2
4.	23	55	20	2
5.	20	58	20.5	1.5
6.	18	60	21	1
7.	16	61.6	21.2	1.2
8.	15	63	21	1
9.	13	64	22	1
10.	12	65	22	1
11.	11	66	22	1
12.	10	67	22	1
13.	10	67.25	22	0.75
14.	9.25	68	22	0.75
15.	9	68.35	22	0.65

Violet-colored fires.

No.	Potassium Chlorate. Per cent.	Calcium Carbonate. Per cent.	Malachite powdered. Per cent.	Sulphur. Per cent.
1.	52	29	4	15
2.	52	28	5	15
3.	52	26	7	15
4.	52	24	9	15
5.	52	23	10	15
6.	52	21	13	15
7.	51	20	14	15
8.	51	18	16	15
9.	51	16	18	15
10.	51	15	19	15
11.	51	13	21	15
12.	51	11	23	15
13.	51	10	24	15
14.	51	8	26	15
15.	51	6	28	15

—*Chemical News.*

DETERMINATION OF GOLD IN PYRITES.

By M. H. SCHWARZ.

THE author melts 100 grms. pyrites with 46.6 grms. fine iron turnings under a layer of common salt. The mono-sulphide formed is powdered, and attacked with dilute sulphuric acid in a gas apparatus, the sulphuretted hydrogen being received in ammonia. The matter insoluble in acid is collected, washed, dried, and roasted. It is then mixed with borax and about 2 grms. granulated lead, and the mixture melted in a muffle until the lead collects in a single globule floating in ferruginous scoriæ. This globule is detached, and submitted to cupellation.

CEMENT FOR GLYCERINE MOUNTING.

MR. KITTON, whose authority on this subject is admitted, gives the following piece of advice in a recent number of *Science Gossip:* White lead in powder, red ditto in ditto, litharge in ditto—equal parts of each. These are ground together with a little turpentine until thoroughly incorporated, then mix with gold size. The mixture should be sufficiently thin to work with the brush; it is perhaps scarcely necessary to say that the edge of cover and slide should be free from moisture before applying the cement, and the first coat allowed to dry before putting on a second. The last can be applied somewhat thickly, or, as the japanners say, floated on. No more of the cement should be made than is required for present use, as it soon sets and becomes unworkable. To save the trouble of grinding, a stock of the mixture can be kept ready ground in a bottle.

SALICYLIC COTTON WADDING.

FOR this purpose a white wadding completely freed from fat by sodium carbonate is necessary. E. Rennard saturates in a porcelain mortar 10 parts of this wadding with a solution of 2 parts salicylic acid in 15 of alcohol, and 35 of water of 25 to 30° C. (77° to 86° F.). After the solution has been completely absorbed, and uniformly distributed through the cotton, the latter is subjected to pressure until 25 parts of the solution are recovered, which may be used for wetting a fresh portion of cotton. If it is desired to avoid expression, only one part of salicylic acid is employed, but the full quantity of liquid mentioned above, which is about the smallest quantity with which a uniform moistening of the cotton can be effected. The wadding is then dried at ordinary temperature, since a higher heat causes a reddish color. Thiersch has recommended the addition of some glycerine, in order to fix the acid more permanently upon the cotton; but Rennard states

that the addition of 10 and even 20 per cent of glycerine will not completely prevent the dusting of the acid on beating the cotton. The above proportions furnish a wadding impregnated with 10 per cent of salicylic acid; this strength and a wadding containing four per cent are most generally employed.—*Zeitsch. Oester. Ap. Ver.*

ACTION OF LIGHT ON PURE AND COLORED SILVER BROMIDE.

By HERMAN W. VOGEL.

THE results of the investigation are thus stated

1. Pure silver bromide when exposed long enough to a spectrum which is light enough, is sensitive as far as the ultra red.
2. Methyl violet and cyanin both increase the sensitiveness of silver bromide for those parts of the spectrum which they absorb.
3. The plates may be best colored by pouring an alcoholic solution of the coloring matter upon the prepared silver bromide plate, and then allowing to dry.
4. If the plates are too strongly colored, too much of the light is absorbed before reaching the silver bromide. This difficulty is most easily overcome by exposing the back side of the plate to the light, which thus first reaches the silver bromide.

VORTEX SMOKE RINGS.

AT one of the recent *conversaziones* of the British Association, Sir W. Thomson exhibited the vortex smoke rings. A box of about 3 feet square has a circular hole of about 6 inches in diameter cut in its front face, and the back is covered by a piece of tightly stretched canvas or linen. The vapors of ammonia and hydrochloric acid are admitted to the box, which soon becomes filled with the white smoke of chloride of ammonium. A sharp but gentle tap on the canvas back drives out a puff of the smoke, which traverses the room in the form of a beautiful ring. So great a velocity can be imparted to these vortex rings that even when at a considerable distance they have sufficient velocity to extinguish candles. The experiment is remarkably simple, and with a little care in securing good ventilation, it may be performed without injury to persons or things in a drawing-room.

HOW TO USE PHOTOGRAPHIC BACKGROUNDS.

By L. W. SEAVEY.

[With Fourteen Illustrations. Continued from page 766.]

HERE is another position (No. 8), one of repose. Here the figure is well relieved by the shadows in the background.

The lady is supposed to be leaning, if that term may be applied, against the shadow that is produced by an accessory.

Under the head of *peculiar* positions, where the background plays an important part, you have in No. 9 that which is known as a circular composition, in which the background is used to carry out the line of the figure.

FIG. 8.

Now, as to some of the errors I have noticed in using backgrounds. Here is one you may see in the Russian department of Photographic Hall, a landscape, and the subject has been so placed that a tree appears to be coming right out of the top of the head. (No. 10.)

Here is one in the American department, in which you have what may be called the pyramidal composition! ! (No. 11.)

I have an incident to tell you, which I think has never been told. Some two years ago I received a letter from a stockhouse in Philadelphia, ordering a landscape sea view background, one which we designate as the Evangeline, which some of you know; also for a rustic arbor and fence. Quite a little bill! The photographer had been successful; he thought he would invest some money in backgrounds and accessories. The order was filled at my establishment, and being shipped to the stockdealer we did not know who finally received it. About a month afterwards I was making a short tour through the country, calling on my photographic friends for the purpose of drumming up business. I was very much surprised one day, on entering a gallery, at seeing a background, which in color made me think it had been executed either by myself or by one of my artists; but the design was something new to me, I had never seen anything like it before. The rustic arbor and fence I recognized at once. After a moment I comprehended the matter. The photographer had, in mounting the background, turned it so that the horizon line was vertical; he afterwards told me he could not tell which end should be up, so in his dilemma he called in his friends and they had a regular consultation, and finally concluded that a point of land extending into the water was a church steeple, and therefore it should be placed in the way in which I found it. I will make a sketch of the background, showing the effect produced by the manner in which they placed it. (No. 12.)

When he posed his subjects he put them directly under that line (indicating). I have frequently seen the old-fashioned base-boards in front of landscape backgrounds; they should never be used with even plain or interior backgrounds. I hardly need mention this to *you*, for I am sure those present never make such mistakes. If possible, the junction of the background and floor should be hidden, either by shadows

FIG. 9.

or by placing an accessory to hide the line. The foregoing is essential in order that the picture may have a realistic appearance.

Occasionally a customer, on seeing a proof, complains that the hair sticks out (No. 13), or something else sticks up, and you reply that you do not photograph hair and bows. I claim that you do photograph them. I claim that it is the duty of every photographer to look at the personal adornments of the subject, and arrange them with the same degree of care that

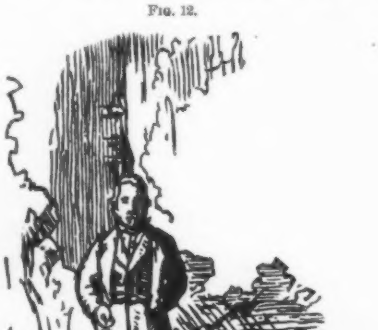
FIG. 10.

FIG. 11.

an artist in a studio does in posing his model for a picture which he desires to paint.

If a lady enters a gallery having ribbons and bows over the top of her head, I think it would be hardly proper to make them look like this (indicating), or letting them stick up so (No. 14) (indicating). (Applause and laughter.) The photographer holds a very important place in the com-

FIG. 12.



munity in which he is located, especially when he puts out his sign as an *artistic* one. The people look to him as the leader of and authority on art in their particular neighborhood. I don't know whether all realize it or not. You represent their friends, their homes, and their families, and they are dependent upon you, and it is your duty to elevate the artistic tastes of the community and thereby benefit yourself by interesting them in your work.

I wish to say something about the Photographic Convention. The photographic conventions or exhibitions are to me a source of valuable instruction. By them about the only opportunity is afforded by which I can ascertain your standing, by which I can see how my backgrounds are used, or how you have improved upon my efforts. Our welfare is mutual. And if I make mistakes, as I frequently do, you should point them out in a friendly and kindly way, and allow me to do the same when you have erred.

At the conventions I examine the pictures carefully, to see how my backgrounds have been used. I often see instances where they have been well used. Valuable suggestions are made to me, and if I see good result I make a memorandum or sketch of it, and lay it away for future reference. I have, at this Exhibition, obtained quite a number of new ideas, which in the course of time will be scattered abroad in works going to you from my studio.

Occasionally I receive letters finding fault with my backgrounds, that they are not dark enough in the shadows, or that they are too light; and I have occasionally sent for proofs: and in several instances where the complaint had been that they were too light, have found the photographer had been using the background turned somewhat towards the side-light. We have great difficulty in painting backgrounds to make the shadows as intense as they are in nature. It is really impossible. As the photographic value depends upon the relative degree of light and shade in the background, it should be placed at right angles to the side-light or with the side-wall of the room.

FIG. 13.

FIG. 14.

Mr. Whitney, of Norwalk, here asked what style of background Mr. Seavey would recommend for heads and busts.

I think, for these purposes there should be no design in a background, except of a simple arrangement of light and shade. For bust work it should be darkest at the bottom, growing gradually lighter towards the top. I think, in bust pictures, the background should be so retiring that the spectator will not notice that a background has been used.

I wish to say about skylights, that most of you make your skylight rooms so small that you have not room for more than one or two backgrounds, with scarcely any accessories. What would be thought of the portrait artist, or of the painter of figure subjects, were he to paint one background which would be found in every picture coming from his easel. You should have room for several backgrounds for producing different kinds of pictures in vogue, and room for your accessories, so that you may use them without being annoyed or worried by having them in the way.

At the conclusion of Mr. Seavey's address, he was complimented by the president and others, and a vote of thanks tendered him for the admirable manner in which he had shown the use and workings of backgrounds.

TRANSPARENCIES AND ENLARGEMENTS.

THE great drawback heretofore felt in making transparencies, and enlarged negatives therefrom, has been the "fuzziness" or blurred appearance of the resulting picture. Where a transparency is made in direct contact with the negative by any of the known dry-plate processes (if contact is perfect), no blurring will be perceptible, and the resulting transparency will be as sharp as the original negative. Now take this transparency and use it for an enlarged negative by any means I have seen recommended—namely, place in front of your object-lens and pass the light through it, either direct from the sky or reflected from a white screen, and in proportion to the diameters will be the blurring of your resulting negative. I have found that all this can be avoided by placing in front of the negative you wish to make transparencies from, either for the lantern or duplicate, or enlarged negative, first next to the window, or, better still, clear daylight, a porcelain plate (a thin one); next to this two or even three thicknesses of (finely ground) ground glass, ground side out. Inside of this place your negative, collodion side to the object glass; focus with full, open tube, and, before exposing the plate, insert small stop. The result will be a transparency or negative free from all blurring, sharp and clear as the original negative. Now place this in place of the original negative, and proceed to make your enlarged negative.

I neverhave seen this idea mentioned by any one, but all who will try it will at once be convinced of the great advantage to be gained by the use of porcelain and ground glass, as already mentioned.—A. HESLER.

MICROSCOPIC OBSERVATION OF MINUTE OBJECTS.

AT the meeting of the Academy of Sciences of Philadelphia (May 9), Professor Frazer remarked that he desired to put on record a thought relating to Helmholtz's now famous establishment of the limit of vision through the microscope. As this limit was determined by half the length of a wave of light, and since the wave-lengths of the most refrangible rays of the light spectrum (that is, the violet) are somewhere near the $\frac{1}{57000}$ part of an inch, the conclusion was reached that nothing more minute than the $\frac{1}{114000}$ part of an inch could be seen. But actinic waves or others of smaller length (of greater refrangibility too) in passing through a substance on which are lines or other markings less than $\frac{1}{114000}$ inch apart, may be altered to light waves, and become visible, provided that the substance through which they pass is capable of fluorescing—that is, increasing their wave length—and provided the distance apart of the marks to be seen is not less than one half the wave-length of such actinic waves.